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Night View of Plant Showing It Illuminated with Monticello Search Light. The Secondary Aerators are in the Foreground

Slow Sand Filtration at Charlottesville, Va.

The Development and Results of Operation

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AN historical summary of the development of the Charlottesville Water System is essential to complete understanding of the treatment problem as is a description of the physical elements of the system.

Prior to 1925, Charlottesville's water supply was from two impounding reservoirs, located in the "Ragged" mountains about three miles southwest of the town. In elevation the reservoirs are deficient for adequate pressures in the western part of the city and at the University of Virginia.

This supply demonstrated its inadequacy as early as 1918. During the late spring, summer and early fall the water had an intensely disagreeable odor, taste and color, resulting principally from algae. Copper sulphate treatment was resorted to, but with little success.

In 1922 a pumping station was constructed on Maury Creek, a small stream flowing from the drainage area below the reservoirs, pumping back into the reservoirs for storage, a means of augmentation which not only did not improve the stored water but which was expensive due to high heads.

During the summer of 1921 the situation, both as regards inadequacy of the supply and the repellant physical characteristics of the water, became unbearable and the city officials began investigations of additional sources simultaneously with studies of treatment requirements. Surveys were made of all available sources including the Rivanna River, with the result that a gravity supply from Moorman's River was clearly demonstrated as the logical addition to the supply.

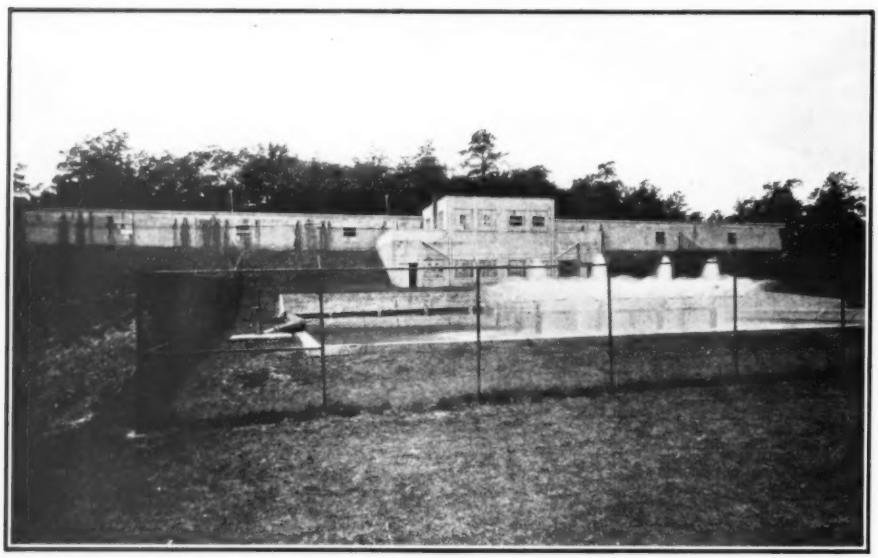
On Nov. 11, 1921, George W. Fuller of New York, Dr. M. G. Perrow of Lynchburg, Major R. Messer, Chief Engineer of the Virginia Board of Health, and myself reported unanimously in favor of a slow sand filter with preaeration, located on the Observatory Mountain, as sufficient and most economical treatment of both existing and proposed supplies. Construction was immediately begun and operation commenced in the Fall of 1922.

In 1922 and 1923, there were again acute shortages which were temporarily relieved by the installation of modern pumping equipment at Maury's Creek, so connected as to pump direct to the

new filter plant. Early in 1924 the development of the Moorman's River source was begun and the water turned into the mains on March 30, 1925.

The Completed System.—The completed system at Charlottesville, therefore, may be briefly described as follows:

The intake, consisting of simply a diversion weir, is situated in Jarman's Gap developing a total drainage area of approximately 23 sq. mi. of rough, mountainous, heavily forested land. Just below the intake is situated the grit chamber and from this an 18 in. cast iron conduit leads to the storage reservoirs near the city. This conduit is designed for pressure on the hydraulic gradient so that the only cut off is at the intake. Topography, however, allows short lengths to be drained in case of emergency repairs. The 18 in. line connects into the old 18 in. and 10 in. mains from the storage reservoirs to the filter plant, so cross connected that water may be drawn from either the reservoirs or direct from Moorman's River through either the 18 in. or 10 in. main.



General View of Plant, Showing Secondary Aerators in Foreground

With this system of connection it was necessary to prevent static pressure on the pipe line by closing valves at the filter plant or at the cross connection. Moreover, the Moorman's River conduit has a far greater capacity than present requirements and it as desired to store Moorman's River water in the reservoirs whenever possible. An open control chamber was, therefore, constructed on the hydraulic gradient so that in case of a shut down below this point all water flowed to storage in the reservoirs through the control chamber or under normal conditions the excess supply from Moorman's River, over the demand at the filter plant, flows through the control chamber to storage.

A booster station for use when drawing from the reservoirs is located near the filter plant with suitable connections to allow combined use of Moorman's River water by gravity and boosted water from the reservoir. Eighteen, 10 and 6 in. mains lead from the clear-water reservoir to the distributing system in the city.

Basic Elements in Selecting Treatment Plant.—The 1921 survey of purification requirements discovered the following elements as basic in selecting the location, type size and extent of treatment plant.

1. Two sites were available, (a) at the Impounding reservoirs and (b) on the Observatory Mountain near the University.

2. The location in elevation should be such that delivery by gravity to all parts of the city then developed or or likely to be developed in the future could be accomplished. This required the correction of notable pressure deficiencies in the western part of the city and at the university. The location was further qualified by the requirement that a supply from Moorman's River could be economically brought in by gravity, without seriously curtailing its drainage area.

3. The situation demanded a location lending its self to economical and speedy construction, with due regard for facility of operation.

1. Treatment of the existing supply required:

(a) Removal of some pollution though the water shed was municipally owned.

(b) The removal of color, taste and odor of a marked degree.

(c) The reduction of iron.

(d) The removal of very slight turbidity.

2. Treatment of the proposed new supply from Moorman's required:

(a) Removal of possible pollution. No part of the shed being owned by the city, the drainage area being 25 sq. mi., impossible of acquisition and difficu to patrol if acquired.

(b) The removal of fairly large suspended matter during the periods o flood flows.

(c) The reduction of iron.

Water from both supplies was very soft, moderately high in iron and it was evident that large volumes of fresh, clear water from Moorman's River added to the impounded supply, would vitalize the latter and greatly improve its quality.

Capacity.—1. A Pitometer survey in 1920 showed the average daily consumption as approximately 1 Mg. with the per capita consumption about normal.

2. Provision for a service supply, situated by physical necessity well away from the points of demand and the desirability of a uniform rate of filter operation dictated a large clear water reservoir. Peak rates were then secondary in the determination of the total plant capacity though they further influenced selection of a large clear well capacity as an investment economy over increased plant capacity.

Consideration of these principal, and numerous other secondary, elements, together with careful study as to the ultimate economy to be gained, led to unanimous recommendation of the slow sand type of filter with aeration, with the following thoughts uppermost as regards location, type and size.

The location at the old reservoirs was very inaccessible, served by no improved roads, and requiring a 5-mile haul for construction materials. Conversely, the observatory location was close, easily accessible, and provided many advantages and economies, both of construction and operation.

The turbidity to be removed was well within the proven ability of slow sand filters without coagulation or pre-treatment. The taste and odor being principally due to various forms of algae, were capable of adequate treatment by aeration, as was reasonable reduction of iron. The color, though high, was not beyond the capacity of the slow sand type, whose high bacterial efficiency has been undeniably demonstrated.

Simplicity of operation and consequent lower labor costs, the elimination of chemicals, lower wash water requirements, and the small size of the plant presented marked economies, in this particular case, even in the face of greater investment per unit of capacity for the slow sand filters over that for mechanical. In short, the situation was ideal for the slow sand filter with no single feature demanding mechanical filter treatment. Selection of the slow sand filter, in this instance, is as obviously correct as is the selection of the mechanical filters for the city of Richmond, for instance.

With an average demand of 1 Mgd. and clear well capacity of 1 Mg., this capacity being selected primarily in

Primary Aerators at Rear of Plant

deference to its distance from the point of demand, the desirability of a uniform operating rate and economy of Filter Construction, it seemed amply sufficient to provide 2 Mg. of Filter capacity.

Basic Data for Design.—Accordingly, the design was developed from the following basic data:

Capacity 2 Mgd.

Rate: 5 Mg. per acre per day.

115 gal. per sq. ft. per day.

08 gal. per sq. ft. per minute.

This determined the total area as .4 of an acre which was divided into 4 beds of .1 acre each.

Gravel was 12 in. deep as below.

7 in. retained by 1 in. mesh, none over 2 in.

2½ in. passing 1 in. mesh retained by ⅜ in. mesh.

2½ in. passing ⅜ in. mesh with effective size of 2 to 3 MM.

Sand was 36 in. deep as follows:

Maximum turbidity 200 p.p.m. Silica sbd.

Effection size .36 MM.

Uniformity coefficient 2.00.

The under drains were 12 in. split tile with joints laid ¾ in. open.

The area drained by each line of tile was 1,089 sq. ft. as against 1,200 sq. ft. maximum area for efficient velocity.

Friction in drainage system .09 ft.

All piping was amply large with the express purpose of conserving friction resulting in the following velocities:

Under drains, .55 ft. per sec.

Main Collector Lines, .90 ft. per sec.

Effluent Lines, .99 ft. per sec.

Troubles Operating and Their Correction.—During the first few weeks of operation the effluent had a milky color due probably, to silacious material in the sand bed. This cleared nicely, however, and at about the same time the bacterial efficiency began to pick up.

During the first summer the water from the reservoirs was at its worst due to drought and stagnation. The beds clogged rapidly and for several weeks had to be cleaned once a week. Then a red slime appeared in the clear water reservoir, having the appearance of red mud, in which small red worms bred. Experiments were at once started to determine the cause and it was found that the water was abnormally high in iron in the ferrous state which thus passed the filters in solution, was oxidized by aeration and precipitated as ferric iron in the clear well.

The remedy was the installation of aerators ahead of the filters with sufficient detention for the floc to form. The installation of this equipment relieved the clogging of the filters so that a minimum period of two weeks was maintained between scrapings when bad weather prevailed.

Enlargement.—After this correction, the effluent was excellent and in spite of the rapid installation of meters the consumption increased perceptibly. Moreover, certain industries who had previously maintained private supplies asked to be supplied from the municipal system. Since their demands totalled several hundred thousand gallons daily it became necessary to study means of increasing the filter capacity.

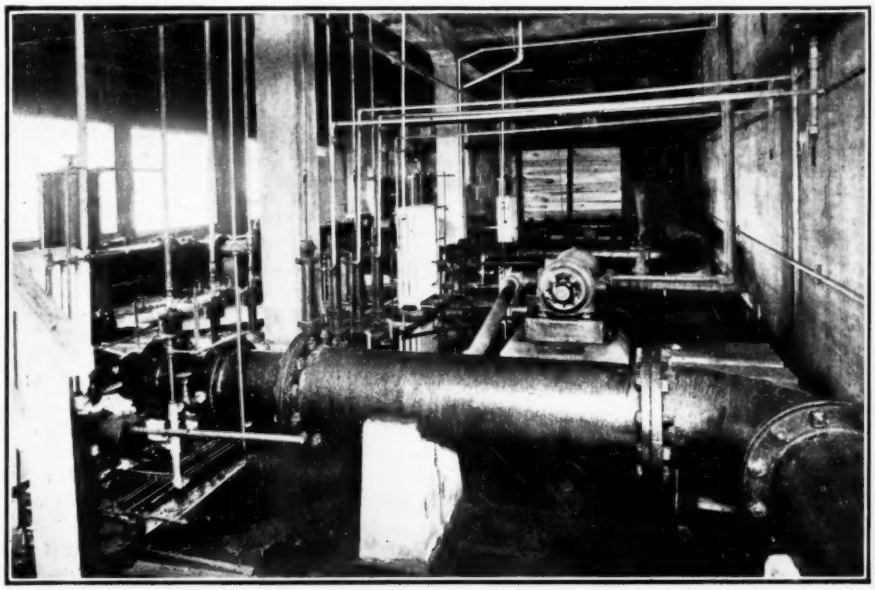
Studies were made on the basis of additional 3 Mgd. per acre rate filters with estimates of cost and found to be beyond the then financial ability of the city.

In studying the troubles encountered during early operation, an experimental filter was constructed and the results obtained indicated the possibility of using a higher rate of filtration, especially since the Moorman's River supply was assured and improvement of the raw water, even during the summer months was confidently expected. With completion of the new supply, better water was an accomplished fact, therefore the city council subsidized a series of experiments during the summer of 1925. These covered operation of a small experimental plant at various rates with studies of the water during all stages of the processes, together with studies of the water in its passage through the slow sand plant.

These experiments were made under conditions which were as adverse as can be expected, that is, when most of the water was being furnished from the storage reservoirs during an exceedingly dry season and before the Moorman's River supply had time to reach its maximum effectiveness in the improvement of the impounded supply.

The results may be summarized briefly as follows:

This water had no characteristics which would preclude an increase of rate to 10 Mg. per acre per day. Both color and turbidity ranged between 20 and 27 parts per million. In was found, however, that the water was very high



Controller Room and Pipe Gallery

in iron and the importance of preliminary aeration was clearly demonstrated. That is, it was necessary to remove as much of the iron carried in solution as possible, as otherwise it so passed the filters and was precipitated by the secondary aeration. Since preliminary aeration causes the formation of a floc the question of providing settling basins ahead of the filters was studied carefully with the idea that the load on the filters might be materially reduced by allowing the floc formed to precipitate out before the water was applied to the filters. It was found, however, that due to the nature of the floc, a period of about 15 minutes was all that was justified, since over a six hour period, only 17 per cent settled out and 65 per cent of this was settled out during the first 15 minutes.

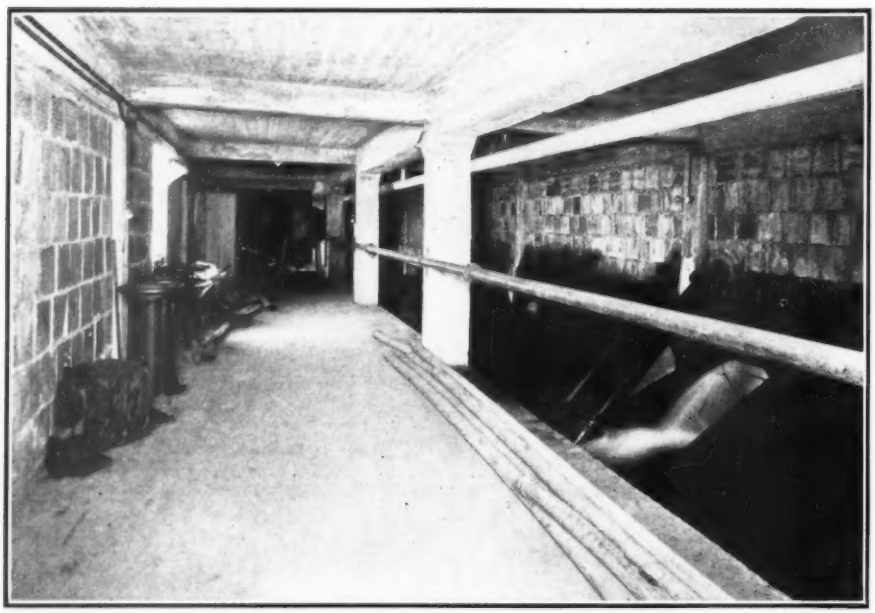
The experimental filter was rigged with a pre-aerator and 15 minutes sedimentation ahead of the filter, with a secondary aerator after filtration. Operating at a 10 million gallon rate the effluent was excellent, the following tabulation showing the condition of the water at various stages of the process:

	Raw Water	First Aeration	After Filtration	Secondary Aeration
Temperature OC	23.5	23.5	23.5	23.5
Turbidity	27.0	25	5.0	5.0
Taste	Faint, Earthy	Faint, Earthy	0	0
Color (apparent)	21	20	3	3
Alkalinity	0	0	0	0
Hydroxide (OH)				
Carbonate (CO_3)	0	0	0	0
Bicarbonate (HCO_3)	18.5	17.9	18.1	17.5
(In terms of $CaCO_3$)				
Iron	0.76	0.70	.04	.04
Free Carbon Dioxide	9.30	3.7	6.1	1.6
Dissolved Oxygen	1.54	6.01	2.04	8.07
Per Cent of Saturation	17.9	69.8	23.7	93.8

Practically rates as high as 10 Mg. per day had been used only in an experimental way in this country, the most noteworthy experiment having been carried out at the Washington filter plant during 1908 to 1910, inclusive, covering a period of approximately 1½ years. These experiments were made with Potomac River water at best infinitely more turbid than the Charlottesville supply at its worst. They demonstrated that up to a rate of 10 Mg. the loss in bacterial efficiency was very small and that the cost of filtration was approximately 33 per cent lower than with a rate of 5 Mg.; also experiments at the Lawrence filters showed practically the same results, that is, that bacterial efficiency was very slightly decreased between rates of 5 and 10 Mg. per acre.

Both experiments, however, demonstrated the importance of the cleaning method used, as uniformly better results were obtained when the filters were cleaned by scraping, as is the usual method for cleaning this type of bed, than was the case when they were cleaned by the reverse flow method.

As a result, one filter was revamped to operate at the new rate of 10 Mg. per acre per day by increasing the aerator capacity ahead of the filter and providing 15 minutes sedimentation; reconstructing the drainage system by installing two 10-in. by 12-in main collectors and 6-in. split tile laterals; and installing new controller equipment of increased capacity. Thus a filter which previously had 5 Mgd. capacity new has been doubled.



Operating Gallery and Nichols Sand Washing Machine

The results obtained were in every respect excellent and the period between scrapings was not perceptibly shortened. The three other beds were, therefore, similarly revamped at a total cost, including the absorption of the experimental cost of $16,936.84 or $8,468.42 per Mg. of increased capacity. These figures also included the replacement of some sand and gravel lost during the change. Also the new sand was carefully selected and carefully mixed with the old sand so as to reduce the effective size to .34 mm. and to somewhat improve the uniformity coefficient. The mixing was accomplished by repeated washings with the Nichols machine.

The cost of $8,468 per 1,000,000 gal. of increase may be compared with $51,000, the estimated cost per 1,000,000 gal. of capacity of additional filters operating on a 5,000,000 gal. per acre rate.

No major troubles, either of operation or sufficiency of treatment, have been encountered since the revamped plant was put into operation in the summer of 1926 but, as will be later shown, the cost of operation has been steadily lowered. The average time between scrapings for 2½ years' operation on the 10 Mg. rate approximates 50 days, or only 10 per cent less than the period obtained when the lower rate was used. The sanitary and physical characteristics of the water have equaled in every respect the effluent obtained with the 5 Mg. per acre rate.

During summer months when the iron precipitate was heavy it was found that the installation of a coke screen over the outlet from the preliminary aeration basins relieved the filters of considerable load. These were so arranged as to be readily cleaned and cost only a few dollars each.

Cost of Operation.—In determining the cost of operation only the actual cost of treatment and purification functions are included. Similarly the fixed charges represent only actual investment in treatment and purification works. This method of cost determination is based on the theory that booster pumping and service water storage should have been provided whether or not treatment was necessary.

Thusly, the average yearly cost of water treatment, exclusive of fixed charges, has been as shown in Table I.

The high costs of 1922 and to 1924 are caused by treatment of Maury's Creek water in part and to the generally poor condition of the impounded water during the period immediately preceding completion of the Moorman's River supply. The principal element of cost being labor for scraping and washing during the summer and early fall months.

The plant has been in operation since November, 1922, and this time is log-

Table I

	'22-'23	'23-'24	'24-'25	'25-'26	'26-'27	'27-'28	'28-'29*
Aver. cost of treatment per 1,000,000 gal...	$14.28	$16.78	$7.23	$7.42	$7.90	$5.95	$5.99

*Seven months only.

ically divided into three periods: First, November, 1922 to April, 1925, during which all water came from the impounding reservoirs and Maury's Creek. This water represents the most adverse conditions and covers the starting up and shake down period. The average cost for the period was $8.94 per Mg. Rate of filtration was 5 Mg. per acre per day. Second, April, 1925, to June, 1926, during which Moorman's River water was available, causing a constant improvement of the raw water operation at the 5 Mg. per acre rate, during which water was as under the second phase, but the rate of filtration was 10 Mg. per acre per day, average cost $6.65, or 10 per cent lower than under the same conditions with a 5 Mg. rate.

The average cost over the entire period of operation is $8.94 per Mg. Over the period covering the 5 Mg. rate $11.68 per Mg. and over the 10 Mg. rate period $6.61 per Mg.

These costs include all labor, supplies, maintenance and repairs, together with light and power for washing sand.

The fixed charges over the entire period of operation average $13.53 per 1,000,000 gal., and include a sinking fund for retirement of the outstanding bonds, making a total cost at present of $20.18 per Mg. or .02018 ct. per 1,000 gal.

Acknowledgment.—The foregoing is a paper presented at the First Virginia Conference on Water Purification and Sewage Treatment, held April 25 and 26 at Richmond. Va.

Laying a Reinforced Concrete Outfall Sewer

Steps in the laying of the new San Rafael, Calif., outfall sewer are shown in the accompanying photographs. Sewage is pumped through this line from San Rafael to an outlet in San Francisco Bay. The sewer is built of centrifugally-spun reinforced-concrete pipe of 21-in. internal diameter. Pressures in the line are relatively high, sections of the pipe being reinforced to withstand a 100-ft. head. The design was based upon the estimated population in 1948.

At the End of the Pipe in Place. The Horse Moves Along on Rollers to Handle the Next Section

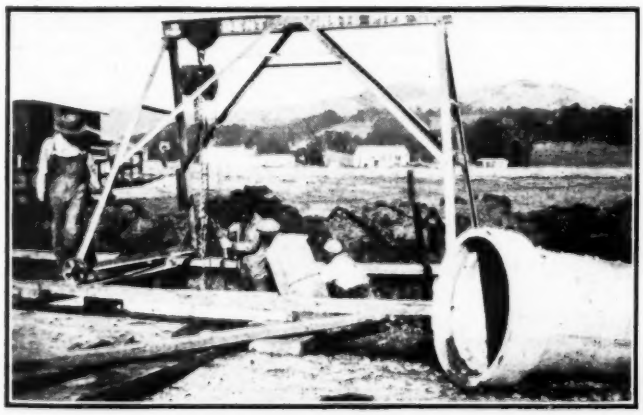
The pipe, which was supplied by the Bent Concrete Pipe Co., was transported from the Oakland plant of that company to San Rafael on barges. At San Rafael it was loaded on trucks and carried to various points along the line where it was unloaded. One of the illustrations shows a derrick unloading pipe from a barge to the pier. A chain hoist, suspended from a heavy steel horse, was used to lower the sections of pipe into the trench. Planks were placed across the trench beneath the hoist, and the sections were rolled over the trench. They were then picked up by the hoist and the planks were removed, allowing the pipe to be lowered into the trench. Redwood cradles were installed in the bottom of the trench to carry the pipe. The horse is provided with small wheels so that it may be moved along the trench on planks laid at the sides. For a wider trench, the wheels may be changed and the horse turned the other way.

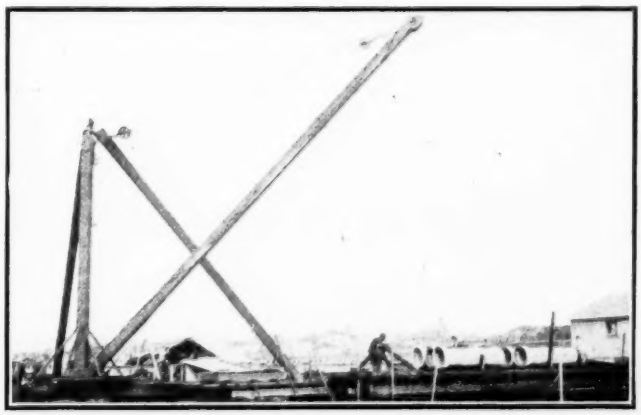
City's Powers Defined

Authority of a city to delegate administrative powers and authority for the enforcement of health regulations was sustained in a recent decision of the Ohio Supreme Court in the case of the State ex rel. George Moock, et al, vs. the City of Cincinnati, et al, on appeal from the Court of Appeals of Hamilton County, according to Ohio Health News of June 1. This was a case growing out of denial of a permit to Moock to collect garbage after a contract had been entered into with another contractor for garbage collection and disposal. The opinion was by Judge Jones. The syllabus follows:

The city of Cincinnati advertised for and received bids and entered into a contract with a single contractor who for a consideration paid by the city, engaged to collect and remove garbage therefrom in accordance with the city's specifications. A permit was thereupon issued to the city's contractor but denied to the relator who had contracts for garbage removal with various hospitals and restaurants in the city. This garbage, consisting of animal, vegetable and other products, had a commercial value, much of which being adaptable for the feeding of swine.

Held: Neither the city ordinance nor the refusal of the city manager to issue relator a permit for the collection and removal of garbage contravened any provision of the state or federal constitution.





Left—Lowering a Section of Pipe. The Planks Have Been Removed and the Pipe Is on Its Way Down. Right—The Sections of Pipe Were Carried from Oakland to San Rafael on Barges

The Cobble Mountain Dam of Springfield, Massachusetts

Design Features of a $6,143,000 Development

By ALLEN HAZEN
Hazen, Everett & Pirnie, Civil Engineers, New York City

THE Cobble Mountain Dam is being built by the city of Springfield, Mass., as part of a development of its water supply; E. E. Lochridge as chief engineer is in charge of the entire work. H. H. Hatch is resident engineer for the construction of the dam and tunnels. Hazen & Whipple (now Hazen, Everett & Pirnie) the writer's firm has prepared the plans and has acted as consulting engineer, checking the general plans and estimates, and George A. Orrok has aided in connection with the water power and electrical development.

There have been four principal contracts:

(1) The Diversion Tunnel, let in July, 1927, to Coleman Bros., of Boston, and completed about a year later.
(2) The Main Dam, Spillway and Reservoir was let to Winston & Company of Kingston, N. Y., in July, 1928, and
(3) The Cobble Mountain Tunnel to Frazier-Davis Construction Co., of St. Louis, at the same time.
(4) The surge tank, penstock, power house, and electrical equipment to Turner Falls Power and Electric Co.

Some road and other work has been carried out by force account. The buildings over the shafts and some small parts of the work are not yet under contract. It is the intention that the whole works shall be completed by Oct. 1, 1930.

The Cobble Mountain Dam is larger and will cost more than could have been built at this time from water funds at present water rates and with a balanced budget. It is the auxiliary power that makes it financially possible now. The reservoir is very high in elevation and there was an opportunity (recognized when this source was first proposed in 1905) of developing water power when full storage became available.

After extended study in the last years, a contract was entered into with the Turners Falls Electric & Power Co., under which the company joined with the city in carrying out the development and will pay an annual rental for 30 years for the privilege of generating power.

Hydraulic Fill Type Dam.—The dam is of the hydraulic fill type, with a top width of 50 ft. a freeboard of 20 ft. above spillway level, and 13 ft. above the top of the proposed 7 ft. flashboards. The slopes are moderate and become flatter toward the bottom of the dam.

Rock fill will be a feature of the dam, a large block of this material being placed in each of the toes, rising to a total height of about 110 ft. above stream bed. Part of this rockfill was required by the original design, but after the contract was let the amount was increased by arrangement with the contractor as permitted by the specifications under the unit prices of the contract.

As a finish to the downstream toe there will be a concrete arch with a radius of 100 ft. cut securely into solid rock on each side, and resting without being cut into the rock on the bottom, with spaces for drainage underneath. This arch is 35 ft. high and from 14 to 20 ft. thick and cuts off what would otherwise have been an extreme extension of the downstream toe.

The shape of the dam is unusual. The gorge is narrow and curved. The side slopes are approximately 37° or one on 1.33. The bottom width is something like 70 ft. Under these conditions the dam has a length along its crest of only 700 ft., but is 1,505 ft. wide on the bottom measured along the thread of the stream. It is therefore more than twice as wide as long.

The height of the dam measured from the stream bed to the spillway level is 215 ft. with 7 ft. additional to the top of the proposed flashboards. To the roadway level on the top of the dam it is 235 ft. The cutoff trench in rock will extend 10 ft. or more below stream bed and is not included in these heights.

At the proposed flashboard level, elevation 952, the Cobble Mountain reservoir will have an area of 1,120 acres and will contain 22,287 million gallons of water. Of this amount 2,021 million gallons below elevation 840 are not available for power but may be drawn in case of need for water supply.

In addition to the storage in the Cobble Mountain Reservoir the Borden Brook Reservoir, constructed in the year 1909, on a tributary stream, has a capacity 2,500 million gal. Of this, under the arrangement with the Power Company, 1,500 million gal. may be drawn for power and 1,000 million gal. are held as an emergency reserve for water supply.

The volume of Cobble Mountain Dam is approximately 1,800,000 cu. yd. of which something like 400,000 cu. yd. will be rock fill and the remainder earth. All but a small part of the latter will be placed hydraulically.

Because the stream was not straight, the lower parts of the toes are turned on a regularly graduated arrangement so that the contours of the finished dam, in a general way, will be perpendicular to the sides of the valley. The total curvature of the valley is some 90° from one toe to the other and of the dam 60°, leaving 30° at a sharp bend in the stream near the upper toe. The stream bends to the left and this procedure leads to steeper slopes on the faces of the dam along the left bank of the stream and flatter slopes near the right bank.

The procedure in general was to make the desired standard slope, selected in advance, apply approximately on the side where the slope was steepest and to leave a flatter slope, or, in one case, a berm near the right bank of the stream.

The material in the damsite is mica schist rock covered to an average depth of about 4 ft., with soil.

Cut Off Trench.—To prevent seepage through seams in the rock where the core of the dam is to join the rock, a cutoff trench will be cut across the bottom and sides of the valley to a depth to be determined as the work proceeds. In the bottom of this trench will be dug narrower trenches in which concrete walls will be built extending 3 ft. above the bottom of the sider trench. One of the walls will be carried to the top on each side of the valley.

The rock below the bottom of the trench is to be drilled and grouted to cut off seams and make the rock watertight. The clay core will fill the rock trench and cover the concrete cutoff walls and make a watertight seal.

Material for Rock Fill.—The material for the rock fill is obtained from the mica schist in the immediate neighborhood of the dam. The rock rises on each side of the damsite to about 470 ft. above the stream bed or 230 ft. above the top of the dam, affording opportunities for convenient and ample quarries on both sides. The rock excavated in the course of the work, including that from the spillway, is placed in the dam as rock fill.

The mica schist, although suitable

for rock fill, will not crush to make concrete stock and there is no rock in the neighborhood of the work fit for masonry of any class. Williamsburgh granite found in some of the neighboring hills is not suitable for quarrying. There are quarries of excellent granite within 20 miles of the site but the use of this material for masonry was not seriously considered. All material for both the concrete work and the hydraulic fill must be brought from pits about a mile away.

At the dam site that soil will be sluiced into the dam and there are some limited deposits of fine grained material not far away that may be useful in construction.

The Hydraulic Fill.—The borrow pits for the hydraulic fill are glacial deposits of sand and gravel. There are fine grained layers running down, in places, to rock flour. The deposits are extensive and contain many times the required volume of material. Selection will be necessary to secure the required grain sizes. Pits carrying different grades of material will probably require to be operated simultaneously.

The contractor proposes to excavate the material in the pits with steam shovels and to carry it on standard gauge railway track to the dam where it will be dumped from tracks on the top of the rock fills, or from trestles above them, to the toes of the dam. The material will then be sluiced into the dam.

Water for sluicing is to be provided by floating pumps on the pool in the center so that the water used for building the dam will be circulated and kept separate from the water of the running stream, so as to avoid pollution of the water supply.

As the material from which the dam is to be built is sandy and gravelly in character, the problem of control of grain size is quite different from that in several other hydraulic dams recently constructed in which the percentage of clay has been high.

The specifications provide that the material in the central core shall have an effective size of about 0.01 mm., the intention being to secure a material fine enough to be, for practical purposes, watertight, but, on the other hand, coarse enough and pervious enough to permit the core material to drain sufficiently for its own consolidation.

It will be remembered that in some hydraulic dams built in the past (Hydraulic Fill Dams. Am. Soc. C. E., Vol. 83, p. 1713, 1920) the core material has been so fine that it was incapable of drainage within any reasonable length of time! and has remained permanently fluid in the center of the dam. In some cases the pressure of this fluid core has exceeded the resistance of the toes and has ruptured them during construction.

An absolute requirement of stability is therefore that the material should be sufficiently coarse grained as to drain and become solid and stable.

On the other hand, some hydraulic fill rams of sandy material have been so coarse grained and free from fine material that there has been an appreciable amount of leakage through them.

In the case of Cobble Mountain Dam approximate watertightness is desirable and necessary; to this end the core size must be regulated to insure that the completed work will be nearly watertight with only so much seepage as is necessary to insure drainage and stability.

In connection with this important subject a method of elutriation and microscopical examination has been devised to determine the character of the material being placed in the core as the work proceeds.

Diversion Tunnel.—Before beginning construction of the dam itself, it was necessary to divert the water of Little River. Work on a diversion tunnel 1,620 ft. long was started a year in advance. This tunnel is horse-shoe shaped equal to a circle 12 ft. in diameter and has a slope of 18 per 1,000. Its invert is a few feet above ordinary water level at both ends.

In connection with this tunnel there was built a cofferdam of rock fill, as a preliminary operation, so placed that it would form part of the permanent upstream toe of the dam. This was faced with enough soil to secure approximate watertightness. This cofferdam had a height of 70 ft. and was required to hold the water at a level that would produce a velocity in the tunnel to develop its capacity.

The tunnel was designed to have a capacity of 4,000 cu. ft. per second, and amount comfortable in excess of any flood that had been recorded during the 20 years that the stream had been gauged. On Nov. 3, 1927, four months after the contract had been let, there was a great flood. This was at the time of the Vermont flood. The maximum rate of discharge at the intake dam three miles below was 6,100 cu. ft. per second; and the average for 24 hours almost reached 4,000 cu. ft. per second. This was before the diversion of the stream.

The mean flow at the intake dam is about 62 mgd. It will be proportionately less at Cobble Mountain Dam or about 58 mgd.

The diversion tunnel was lined with concrete and the space back of the concrete grouted. At a convenient place a shaft 218 ft. deep was cut from the surface and a place selected upstream from it for the permanent closure and control works. In this place, after the dam is built, a concrete plug will be placed and grouted. Through this two 42 in. pipes will pass, leading to gates and guard gates in duplicate with discharging capacity of more than 1,000 cu. ft. per second, from which water may be drawn for water supply purposes or to lower the water in the dam in any emergency. Otherwise these gates will not be used.

The capacity of the outlets is such that using both tunnels water can be lowered about 3 ft. per 24 hours, the rate of drop increasing as the water falls. The reservoir could be emptied in about 30 days.

The Outlet Tunnel.—The Cobble Mountain tunnel which will be the ordinary outlet and will supply water to the power house, is 7,100 ft. long and is equivalent in area and capacity to a circle 10 ft. in diameter. It is to be concrete lined throughout and grouted. The entrance to this tunnel is 76 ft. in elevation above that of the diversion tunnel. The sill at its entrance is at elevation 830,122 ft below the top of the proposed flashboards.

This tunnel is driven through mica schist rock, similar in character to that penetrated by the diversion tunnel, and, for the most part, completely dry. A small amount of Williamsburg granite, a coarse grained local variety, was encountered. The tunnel location was selected to give ample rock cover to resist pressure, except in the lower 500 ft. which are to be steel line.

The control of water through this tunnel will be, ordinarily, by gates at the power house and otherwise by a gate at the inlet which can be used to hold the water back while the tunnel and penstocks are unwatered for inspection or repair. This gate is a Broome gate 12 ft. wide and 13 ft. high covering a carefully formed bellmouth.

A short section of tunnel upstream from this entrance is so arranged that when the water is drawn down to elevation 900 or lower, it will be possible to sink an emergency gate to cover the outer entrance and to permit the Broome gate and its seat and everything connected with it to be unwatered. The outer gate will not be provided at present, but the seat will be built so that this remedy may be applied at a future time if it should prove necessary.

Power Development.—At the lower end of the tunnel a steel pipe lining will be used extending to a point where the rock above is approximately at the elevation of high water in the reservoir. At its lower end this pipe is connected to a surge tank and then to three penstocks. These go down a steep declivity to the power house which is built at the end of the small reservoir formed by the intake dam. From the intake dam water is drawn to the filters as needed and the rest of the flow spills down the stream.

The flow line of the Cobble Mountain Reservoir, at the flashboard level, will be 456 ft. above the present flow line of the intake reservoir. This possible head on the wheels will be reduced by drawdown in Cobble Mountain Reservoir and by friction in the tunnel and penstocks. The working head will vary from about 450 ft. down to about 350 ft, with a possible extreme minimum of 330 ft.

It will probably average in the neighborhood of 400 ft.

The power house is provided with a capacity to use water at a rate equal to ten times the mean flow of the stream. It will thus operate on a 10 per cent load factor. This relatively large development is provided with reference to using this plant to meet peak loads.

Daily power peaks will be met by drawing the water required for water supply during those hours of the day when the power will be most useful and the city has storage to carry through the day from water so drawn.

The city at present uses a little less than 15 mgd. and the mean flow of the stream is 62 mgd. The difference, 47 mgd., may be stored and drawn on any days or hours when it will be most valuable during the whole course of the year. This condition will permit a large part of the power to be drawn when water power stations, operated by the company on other streams, are short of water and to meet emergency and peak loads of any kind.

The Spillway.—The spillway of a dam of this character is most important. When the work was started the largest flood on record measured at the intake dam was 4,410 cu. ft. per second. After the work was started there was a larger flood as noted above, with a maximum of 6,100 cu. ft. per second.

From a study of the records of flow of this particular stream, the indications are that the greatest average flow for 24 hours to be expected once in a hundred years would be 4,850 cu. ft. per second.

In view of the character of the occupation of the valley below the greatest precautions were warranted against overtopping of the dam, and it was decided to lay out a spillway channel with a capacity of 20,000 cu. ft. per second, equal to more than 436 cu. ft. per second per square mile of tributary area. This is equal to five times the record 24-hour average flood of the record period.

There was an excellent natural site for the spillway through a notch in the mica schist rock on the opposite side of Cobble Mountain from the dam.

Using this notch required a considerable amount of rock excavation but the rock obtained could be placed and is being placed in the dam.

The crest of the spillway was laid out 135 ft. long. The channel from it drops 15 and narrows as a bellmouth to a width of 50 ft. and then extends with a grade of 1 per cent for a total distance of about 700 feet from the entrance, at which point the rock falls off abruptly on a slope of approximately 31° to the river bed. The total vertical drop is about 255 ft. The flow will reach the river about 3,000 ft. downstream from the lower toe of the dam.

With a well-rounded crest and a gradual approach, the spillway should carry 20,000 cu. ft. a second with about thirteen ft. head.

The water level in the reservoir would then be at elevation 958, at which level it would still be 7 ft. below the top of the dam.

The spillway channel was calculated so that at each point, with an assumed water level, which would pass 20,000 cu. ft. per second, the water level, plus the velocity head, plus an estimate for friction from the entrance to that point would equal the assumed reservoir level i. e., 958.

The allowance for friction not being capable of being estimated closely, a liberal and perhaps excessive allowance was made for it, amounting to 1 per cent of the total distance from the entrance to each point of calculation. Water velocities in the neighborhood of 20 ft. per second were estimated.

The estimated cost of the Cobble Mountain dam and reservoir and the power house and of all that goes with it, but not including the Borden Brook Reservoir built in 1909 nor the land, most of which has been previously purchased, nor other parts of the water supply system, is $6,143,000.

Contracts have been let covering the major parts of the work and a substantial part of the work has been done. Some things remain to be arranged. There is every indication at present that the work will be completed for a sum materially less than the estimated cost.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 49th annual convention of the American Water Works Association.

Relation of Direct Bact. Coli and Bact. Aerogenes Counts Obtained with Cyanide-Citrate Agar, to Sources of Pollution

By FRED C. TONNEY AND RALPH E. NOBLE

Bureau of Laboratories and Research Department of Health, Chicago

Recently developed direct plating methods of counting coli-aerogenes organisms have made possible the routine determination of separate Bact. coli and Bact. aerogenes indices in 48 hours by the same process in which the combined Bact. coli-aerogenes index is obtained.

Our experience with such a method, employing cyanide-citrate agar as a different medium, led us to consider the possibility that additional data of primary sanitary significance bearing directly on fecal pollution might be available for practical use, in the individual Bact. coli and individual Bact. aerogenes counts, and also in their numerical relation to each other. It was thought that possibly data derived from separate Bact. coli and Bact. aerogenes determinations might offer a better basis for discriminating sanitary judgment of true fecal pollution than can be arrived at from the combined coli-aerogenes index, which includes a variable number of organisms not strictly of fecal origin.

Confirmation studies of the distinctive type colonies on the medium, designated as "Probable Bact. Coli" and "Probable Bact. Aerogenes," indicated a high degree of agreement between the characteristic appearance of the colonies and the recognized differential tests for these two organisms, viz: the methyl red Vogee-Proskauer reaction, the ferric ammonium citrate and sodium citrate tests and the colony characteristics on eosin-methylene blue plates.

The phase of the investigation here reported was directed toward the primary sources from which these organisms find their way into water supplies. It consisted of a quantitative study of the Bact. coli and Bact. aerogenes content of (1) human and animal feces as the primary source of Bact. coli; (2) soils, decayed vegetation and grains as a primary source of Bact. aerogenes, and (3) sewage as a composite mixture derived from the two primary sources named.

A brief summary of the relationship found is given in Table I.

The data indicate that numerically Bact. coli is the organism primarily characteristic of feces; that Bact. aerogenes, although occurring in feces, is numerically insignificant in the aggregate; that Bact. aerogenes is primarily characteristic of coli and vegetation; that the ratio of Bact. coli to Bact. aerogenes in sewage in the Chicago district points to fecal sources and soil sources as contributing in nearly equal proportions to the total number of coli-aerogenes organisms present.

Acknowledgment.—The above is an abstract of a paper presented at the 49th annual convention of the American Water Works Association.

Table I.—Relationship of Bact. Coli and Bact. Aerogenes Colonies from Fecal and Non-Fecal Sources

Source	Samples	Combined Coli-Aerogenes Average per Gram in Aggregate	Percentage Coli	Percentage Aerogenes	Ratio of Coli to Aerogenes
Feces:					
Human	132	92,800,000	99.63	0.37	270: 1.0
Animal	324	689,000,000	99.42	0.58	145: 1.0
Human and animal	456	517,000,000	99.23	0.77	148: 1.0
Sewage	74	88,700*	41.4	51.6	1: 1.4
Surface water	45	176,000†	10.5	89.5	1: 9.5
Cereals	60	397	5.9	94.1	1: 16.0
Soils	20	1,600	0.44	99.56	1:226.0
Decaying wood	17	7,940	0.22	99.78	1:446.0

*Per cubic centimeter. †Per 100 c. c. ‡Based on aggregate content of each source.

The Importance of Regional Planning

The Need for the Regional Planning Association; Its Problems

By J. R. FAIRMAN

Manager Southeastern Offices, Portland Cement Association

NEARLY everyone has in mind some city improvement he thinks would be of great benefit; one man wants the street on which he lives paved, another wants a park established, still another believes a certain street should be widened, this man would like to install a new system of traffic lights, and so on. With all this disunified thinking and planning, I sometimes am forced to wonder how many communities have achieved any semblance of order.

Almost overnight the automobile has changed our mode of living. Through the ability of the individual to get easily about the country, a new standard of living and of education has developed. A city is no longer self-contained; its prosperity and development depend to a large degree upon the prosperity of an entire region.

Importance of Suburban Communities.—Chief among the several problems confronting the modern city is the provision of adequate facilities for motor traffic. Suburban districts have long existed, but never in all history has their relationship to the city been of such importance and concern as at present. Suburban areas are expanding, cities and their suburbs are now growing together; and the automobile is bringing remote communities nearer to the city. Haphazard growth must be halted, in the face of such tendencies, if a full measure of community efficiency, comfort and beauty is to be attained.

Progressive, populous communities in many parts of the country have adopted regional planning as the medium best adapted to handling this perplexing problem. City planning is not broad enough; our communities are bursting out at the sides. There are greater opportunities in adjacent areas than in the city proper. The picture puzzle of community needs must be solved by trained minds, made available through some such agency as a regional planning commission, whose duties include the analysis of all such factors as population increase, suburban growth, vehicle registration, both present and future, expected industrial development, residential trends, zoning, finances available for improvements and many other items. Equipped with facts, this commission will make recomendations and cooperate with other existing agencies to the end that a regional plan of a comprehensive, forward-looking nature will be carried out.

I had realized, of course, that city populations in Florida were increasing, but I must admit I was somewhat startled to learn that since 1925 the population of Jacksonville has increased by 60 per cent; Tampa, by 85 per cent; Miami, by 128 per cent; and St. Augustine, by 80 per cent.

These growths are phenomenal, yet there is every indication that Florida cities are to continue attracting citizens at a high rate. Your cities still have time to convert themselves into communities that are modern in the fullest meaning of the word.

Unfortunately, regional planning did not exist when most of our cities were created. Without knowledge of the changes to be wrought by the automobile, or of the great size to which cities would grow, the early planners neglected to provide for logical and directed growth. Streets, for instance, were rarely of more than the age old four-rod width. Of all the American cities, with the exception of the nation's capital, the only one I can call to mind that made any early attempt at planning for the future was Detroit.

Experience of Detroit.—That city was destroyed by fire nearly one and a quarter centuries ago, as were so many early communities. Afterwards, a prominent Detroit citizen, Judge Woodward, and Governor Hull of Michigan, were responsible for laying out a new Detroit, a Detroit with thoroughfares of three widths. Streets of minor importance were made 60 ft. wide, secondary radial arteries, 120 ft. and major arteries, 200 ft. This was a marvelous thing, but sadly, later generations, unable to visualize the Detroit of the futre, encroached on these wide rights-of-way and today only a few remnants are in service.

Loss of these broad streets, which would so well have served today's traffic, was a costly thing for Detroit. That city is still paying for it through traffic congestion and through time and money consuming condemnation proceedings and other means to gain back a portion of that space once devoted to streets. All of this could have been avoided through adherence to the original far-seeing plan.

View of Roosevelt Road in Cook County, Illinois

But what Detroit lacks today in extra wide downtown streets, she has made up for in suburban development. A master plan has been adopted that serves as an object lesson for Florida municipalities. This master plan embraces a comprehensive system of wide roads, many of which are already completed, thereby permitting fluidity of present traffic. This plan is a continuing plan; each year definite progress is made toward lengthening the mileage of pavements, none of which is less than 40 ft. wide. In the Detroit region they have a battle cry—"Acquire wider rights-of-way today!" To this might well be added the phrase "for tomorrow they will cost more money."

The master plan predetermines the position of the transportation avenues which form the skeleton of the street system in the outer areas. It provides for superhighways, 204 ft. wide, at three-mile intervals, designed to offer local and through roadways for motor

Waukegan Road in Cook County, Illinois, Widened to 40 Ft.

traffic on each side of a center zone reserved for rapid transit service, or future widening or other development. Intermediate roads 120 ft. wide are located at mile intervals on section lines. A supplementary system of major thoroughfares 120 ft. wide is established at intervals of approximately three-fourths of a mile within the area of present development.

That is indeed an ambitious plan; yet it is already well under way. Words can scarcely convey a true picture of what Detroit and Wayne county have done; I would suggest that if any of you have the opportunity, you spend a week-end in and near the Motor City.

The Regional Planning Association.—Many factors enter into city expansion and development. These are of such a serious nature as to require scientific and thorough study of all the principles involved in order that tax payers may be provided with the facilities and conveniences which are their just due. You will grant, I am sure, that little would be accomplished without some central fact-collecting body to study all the proposals, pushing through to completion those best fitted to the community welfare.

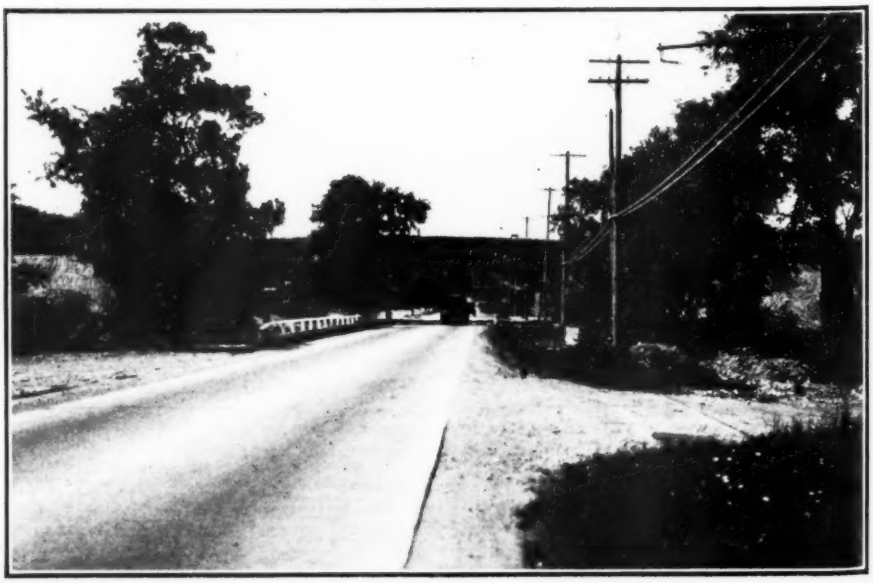
Stated in its simplest form, the purpose of the regional planning association is to make an intensive study of all the factors entering into the community's growth and welfare, so the greatest convenience and comfort may be obtained for the tax dollar. The costly experience of a certain Illinois community must be avoided. There, a splendid 40 ft. pavement was built out into the country, but unfortunately it ended abruptly in a corn field and was of no use whatsoever to the community for a couple of years.

Transportation.—Chief among the problems facing all communities is that of transport. Adequate transport service not only means that railroads and street railways must be well connected, but also that highways and streets shall form a perfect network of main arteries and secondary roads. Street layouts marked by dead-ends, jogs, narrow widths, poor pavement and a total lack of coordination, must be avoided. Industrial traffic must be studied so heavy trucks can be accommodated without hindrance to passenger vehicle traffic. On the other hand, high speed thoroughfares must be constructed so passenger cars will not be unnecessarily delayed by trucks. Through traffic should also be taken care of. The idea that motorists whose destinations are far away should be directed through the downtown section of cities is now old fashioned. By-pass routes must be provided so this traffic can continue on its way unhampered, and what is more important, with no inconvenience to the home community.

Water and Sewage.—Water and sewage must be given careful attention in the makeup of the up-to-date community. The automobile has made it possible for the downtown worker to establish his home in the outer precincts of the city or even out in the country. Sanitation must be carried to him. Villages and suburban centers must cooperate, for in this cooperation the citizen is given better service with complete safety and at lower cost. Without planning, it is too easy for much needed projects to be neglected and to become political footballs. In the Passaic Valley of New Jersey, for example, a trunk sewer now serves a thickly populated region embracing quite a number of separate municipalities. It was proposed to establish this sewer more than twenty years ago, but endless litigation and negotiation was necessary before it became a reality. All this delay was at the public's expense.

Utilities.—Even in the matter of public utilities, the way is open for the city to accomplish a great deal through early planning. Electricity and gas reach out everywhere. Electric lines and conduits through town and country possibly may conflict with the highways. Early planning of highway improvements will give the utility firms an opportunity to develop their facilities for the best interests of the public and also it will aid them in preventing a later conflict for rights-of-way.

Political Obstacles.—One of the greatest achievements open to the regional planning association is the overcoming of problems which I shall call political for want of a better term. The boundaries of governmental units in any region are irregular and often without reason—illogical results of haphazard growth. Areas of municipalities are often either so restricted as to hamper growth, or so extended as to impose some undue burden on the well occupied districts. In the case of the region of



Mona Ave. and Hutchinson River Parkway Grade Separation in Westchester County, New York

Chicago, there are almost exactly 1,000 separate taxing bodies within 50 miles of the downtown section of that city. You are of course not bothered to that degree in Florida. Nevertheless, real progress depends upon the complete cooperation of all governmental units involved.

The Chicago Region.—Here are some of the chief aims of the Chicago Regional Planning Association:

Adequate pavements on every main highway in the region of Chicago, continuous across state, county and city, and their boundary lines.

Adequate paved street connections with the paved highways.

All bridges wide enough for future pavement widening or built so that they may be widened.

Grade separations at all dangerous railway crossings.

Grade separations at the most important highway intersections.

Uniform traffic regulations in every county, city and village region.

Every highway marked only with official, legible signs of cautions and direction.

Every main highway adequately lighted at night.

Trees planted and maintained along every highway for the comfort and delight of all highway users.

Attractive public comfort stations properly located along all important highways.

Chicago, large in itself, is the center of a populous territory and the regional planning problems there are intensified. Nevertheless, the smaller city is faced with the same troubles and identical improvements must come sooner or later.

Planning for a Smaller Community.—Let us look for a moment at the program of a small community—Riverside, Calif., with a population of about 25,000. Riverside has already made remarkable progress and the improvements mapped out for that city bid fair to make it one of the most attractive in the country insofar as appearance, comfort and ease of traffic movement are concerned. Climate is, of course, another matter.

Capitol Drive, 60 Ft. Wide, Milwaukee, Wis.

The steps being taken in Riverside are:

1. Regulation to secure maximum capacity of existing space, including elimination of auto parking, prohibition of obstructive turns at particularly busy intersections, ranking of vehicles, use of most effective signaling, curtailment of unnecessary movements and so forth.

2. Improvement of existing street plan, including elimination of jogs and dead-end traffic streets, creation of distributor and by-pass streets for the business district and improvement of radial and inter-district thoroughfares of the major street plan.

3. Extension of a regional major street plan to cover the whole district for several miles in each direction outside the city limits, and completion of a boulevard and parkway system plan supplementing it.

4. Provision for the readjustment and extension of railroad lines, with gradual elimination of grade-crossings.

Florida Cities.—Regional planning is, of course, quite new and I am much pleased that some of your Florida cities are giving serious consideration to this planning movement. If anything, your problems are more intense than they are in any other part of the country. Florida is growing rapidly, you have a marvelous tourist business, you have an established clientele of winter pleasure seekers. Naturally cities in a state so blessed, will grow faster than the average American city.

Jacksonville, I understand, has a city planner, who is not only confronted with traffic and expansion problems within Jacksonville, but is also obliged to consider the whole of Duval county. Obviously, he must take into consideration the principal arteries of travel into Jacksonville, such as State Road No. 1 from the west and No. 4 from the north and to the south, as well as others.

Travel in that city at present across the St. John's River is over one bridge and by one ferry. Clearly, any comprehensive municipal plan must take into consideration the ever increasing need for additional trans-river transportation facilities. New bridges should be located so as to relieve as much of the intra-city traffic as possible, and provide easy crossing of the St. John's River for through traffic as well as local traffic.

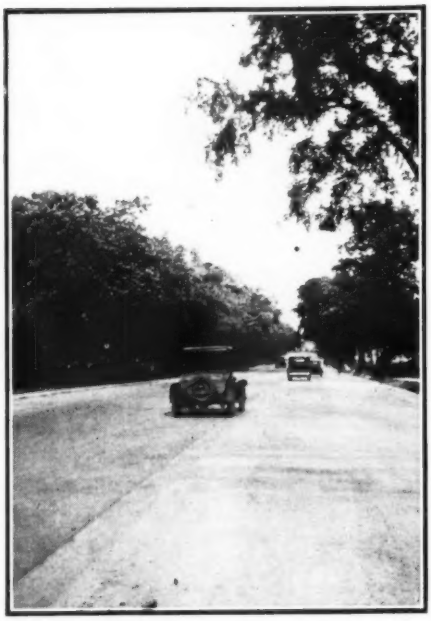
Jacksonville's situation definitely indicates why the modern city must extend its city planning to planning in which the whole region is considered. Tampa presents a problem of similar character. Broad thoroughfares leading into the city must be so located and built as to conform to a plan of the

Four Lane, Hudson River Parkway, Westchester County, New York

greatest possible utility to the city itself.

Miami has already made noteworthy progress through the building of wide arteries. Biscayne Boulevard, 220 ft. wide over an eight-block length, is an excellent example of the type of facility that must be installed if there is ever to be room for the prolific automobile. One of the great difficulties of this modern age is finding a place to park. From this standpoint Biscayne Boulevard is something of a motorists' heaven, for 2,000 cars may be parked along it without hampering travel. You can well imagine what impression Biscayne Boulevard will make on the tourist or home seeker. That latter important individual, particularly will feel, "Here is a city that is progressive, a city that is attempting to make things comfortable for its citizens. I will make my home here."

If your city is smaller than Tampa, Miami and Jacksonville, that does not mean you are freed from the responsibility of regional planning. In fact, it is just as important in the small city as in the large, and frequently more important, for the small community must have something to offer in place of large hotels, office buildings and theatres. Here in St. Augustine there is every indication that before long an improved through route will be needed. Because there is so much of historic interest in this community and so much that must be preserved to the nation for all time, it is highly improbable that the widening of thoroughfares through the old section of the city will be contemplated. However, the ever increasing traffic through the city will shortly demand a broad pavement acting in the nature of a by-pass so the present narrow and winding route may be relieved.



Blue Mound Road, 60 Ft. Wide, Milwaukee County, Wisconsin

Separation of Traffic Arteries.—Superhighways, roads of more than the usual width, elevated street intersections, railroad grade separations, and pedestrian tunnels are a few of the modern facilities forcing themselves into the up-to-date traffic picture. These improvements are no longer regarded with doubt, for cities in many parts of the country have through experimentation proved that they are absolutely practical. One great elevated street separation in Lincoln Park, Chicago, has increased the traffic capacity of Lincoln Park thoroughfares by 300 per cent. That is to say, this one structure has given, in effect, three additional roads. These elevated intersections, wherein one street or road passes over the other, permitting traffic to flow in all four directions continuously and safely, must be placed at strategic points.

The benefits of railroad grade separations are obvious. Surveying accident records, it appears that nothing will eliminate accidents at grade crossings except construction of a bridge over or a tunnel under the tracks so motor and train traffic never will meet.

Need for Wide Thoroughfares.—Wide streets and wide rural roads must be included in every adequate transportation scheme. Thirty years ago the average motor vehicle required a lane only 7 or 8 ft. wide in which to move with ease and safety. Since then the average vehicle width has been increased, the maximum generally being 8 ft. Ordinary speed of travel has doubled or tripled and vehicles have grown tremendously in numbers. Street and highway authorities are agreed that, in metropolitan areas at least, the lane of pavement for moving traffic should 10 ft. wide; for parking parallel to the curb it should be 8 ft.; and for diagonal parking, 18 ft. in width, the latter dimension convertible into an added lane for moving traffic with parallel parking. These lane widths are considered minimum for safety and free movement of traffic under all conditions of light, darkness, rain or dry weather. They are also considered maximum, because a slightly wider lane invites the crowding in of another car, which is dangerous.

The superhighway may roughly be defined as a roadway of ample width for the accommodation of four or more lanes of traffic. Of great importance, is the placement of these

superhighways. They should be so located that the largest number of motorists will be benefited. Superhighways should be built first where they are most needed. Naturally the only way to determine where wide arteries should be built, is by means of a traffic survey. Traffic as it seems and as it actually is, often are two different things. For instance, a traffic count taken at Buffalo, N. Y., revealed figures that surprised even those fairly conversant with that city's traffic problem. More than 50,000,000 vehicle movements across the city line took place in 1927, a daily average movement of over 138,000 vehicles! Other surveys conducted by cities and states throughout the country have in many instances revealed that heavier traffic exists on certain roads than was expected.

Here again there is a definite need for the regional planning association. Varying interests in the community, the ability to pay for additional civic improvements and anticipated future community growth must be considered in location of such thoroughfare.

Acquiring Rights-of-Way.—Another paramount issue is the matter of rights-of-way. The procedure followed by the superhighway commission of Macomb and Wayne and Oakland and Wayne counties, surrounding Detroit, indicates what must be done in all communities expecting to grow. This commission, in anticipation of future highway needs, is acquiring rights-of-way of varying widths up to 200 ft. The width of the original road surfaces has been predetermined. In the future when additional road surface is needed, pavements will be laid without any delay whatsoever.

The regulation of the use of private property by a public agency, through zoning has become well established as a function of government. But what is done by zoning bodies and engineers in the way of placing restriction upon the free use of private property must have a lasting effect upon the community whether the work is well or poorly done—whether the ordinance is well or poorly administered. It is desirable, of course, that the results be the best obtainable.

Through the medium of the regional planning association, and the thorough studies which can be made by such an organization, proper city zoning may be accomplished.

After all, the metropolitan community can be regarded as a child; it must be properly nourished and its development must be properly guided. Clearly, there should be some ruling, guiding hand to correlate the manifold activities of government along this line.

Proper Planning Pays Dividends.—There is no governmental agency authorized or qualified to do the work for a city and its environs too. Whatever is to be accomplished must come through the activities of the citezens themselves. The body necessary to do such work must be non-political, for it must carry on a unified plan through year after year of changing governmental officials. The regional planning associations built up by Chicago, Buffalo, St. Louis and many other cities, have demonstrated the need for such progressive scientific bodies. The modern city is growing more complex. Changes in the organization of the city must come about if it is to keep pace with the changes in our living standards. More is expected of the community than ever before; pure water must always be on hand; streets must be smoothly paved; the schools must be excellent; the parks must be spacious and clean; sewage disposal must be never failing; protection from fire must always be at hand.

All these things cost money, and their costs are personified in the taxes collected by the various governing bodies. If the citizen can be made to realize that the conveniences furnished by his government are in reality part of his personal wealth, that actually through many improvements he receives more than he pays for, he will become more willing to support the improvements which modern conditions require.

All taxpayers are naturally interested in economy; they must be assured that their money is being properly expended. They are demanding that the principles of private business be adopted in conduct of the business of government. The business that is permitted to run itself cannot be as profitable as one that is carefully and thoughtfully directed. Through the medium of a regional planning association the community's growth and future are safeguarded, its funds are most effectively invested in dividend-paying improvements and its energy is most efficiently employed.

Acknowledgment.—The foregoing paper was presented on June 27 before the Florida League of Municipalities at St. Augustine, Fla.

25 Cities Plan Airports

Three New York cities are planning airports or contemplating improvements of existing airports, the Commerce Department announces in making public a list of twenty-five cities in the country where airports are planned. The announcement said that improvements of the Watertown airport are contemplated, while new airports are planned at Middletown and Tupper Lake. Other airports are planned in the following cities:

Eureka, Cal.; Pensacola, Fla.; Brunswick and Montezuma, Ga.; Corbin and Hopkinsville, Ky.; Natchitoches, La.; Calais and Camden, Me.; Winchenden, Mass.; Lake Odessa, Mich.; Benson, Minn.; Pinewald, N. J.; Ephraim, Wis.; Bismarck and Finley, N. D.; Cambridge and Highland, Ohio; Redmond, Ore.; Providence, R. I.; Texon, Texas and Culpeper, Va.

Municipal Yacht Harbors

A survey completed recently by Richard R. Blythe of New York as representative of the National Association of Engine and Boat Manufacturers, shows that a public yacht basin has been a profitable investment for cities. The survey included personal investigations in eleven cities from Boston to Corpus Christi, Tex., as well as reports from a number of other cities.

Miami, which netted $12,435 in nine months out of total income of $14,181, is planning to increase its municipal yacht facilities by 200 per cent.

Detroit, one of the first cities to establish motor-boat wells, netted $9,831 in 1927, but its wells were burned last year and are being replaced with steel and concrete structures to house 288 boats. The city expects an annual profit of $30,000 out of a $250,000 investment. Charges range from $75 to $125 a year, depending on the size of the boat.

Chicago, which has done a great deal for boat owners with anchorages in Lincoln and Jackson parks, is planning to do considerably more, building breakwaters and forming canals as part of its lake front development program. A 42-ft. cruiser pays $30 a year for dockage there; a 60-ft. pays $50.

New York has more pleasure boats and fewer facilities than any waterfront city in the country. The only public accommodations are on the Jersey side of the Hudson, in Palisades Interstate Park. Much conversation is being expended in an effort to get something done for the boat owners there.

Boston is in the same fix as to public facilities, although many private clubs have accessible anchorages.

Down in Houston, Tex., a man bought a speed boat for his sons, discovered there were no adequate facilities, bought a piece of property and developed it, and provided stalls for thirty-five boats. His land cost $20,000 and is now worth some $60,000, according to Blythe's report. Houston is planning a municipal development, as are Galveston, and Corpus Christi on the Gulf, Memphis on the Mississippi and Charleston, S. C.

New York City Increases Pay of Its Employees.—Salary increases to 28,000 employees of New York City who are now receiving $3,640 a year or less, were voted June 27 by the Board of Estimate, to become effective on Sept. 1. Though approximately 10,000 members of the Street Cleaning Department will share the benefits of this action, the greater number of its beneficiaries are enrolled in that class commonly known as white collar workers. The aggregate cost to the city of these increases, it is estimated, will be from $4,250,000 to $4,276,000 yearly.

Sewage Plants and Mosquito Propagation

Relation of Plant Operation to Mosquito Breeding

By JOHN P. PETERSON

Superintendent, The Bergen County Mosquito Extermination Commission, Hackensack, N. J.

IN Bergen County we have closely watched the growth of the county from a cluster of small hamlets to a county of some 350,000 population, and during the growth we have noticed considerable changes in the method of sewage disposal, and the changes were all for the best. While these modern changes were being made in respect to sewage treatment plants, we, of the mosquito control forces, were busy draining swamps, ditching and diking the salt marshes and oiling the city dumps, and paying little attention to areas in the vicinity of the Imhoff tanks. During the past few years we reached a point in our drainage program where we felt we should be getting good results from our labors, only to find that the streams and ponds which we thought to be pure and wholesome were actually breeding large numbers of mosquitoes. We not only found the streams and ponds breeding but also the smaller pools and pockets adjacent to the streams. Close inspections in every case brought out the fact that the water was receiving effluent from a disposal plant.

We also found that some streams had an accumulation of from 6 in. to 8 in. of silt deposited on the bed of the water course. This tended to raise the flow line and consequently, after a heavy rain, would flood the banks and leave pools and pockets of sewage charged water in the swamps alongside of the streams, which in turn would become an ideal breeding place for the Culex Pipien.

These facts were reported to the Commissioners, and they suggested that a survey be made to determine the relation of sewage treatment plant operations with the propagation of mosquitoes.

What the Survey Showed.—The survey brought out the fact that of 42 plants in Bergen County 18 were directly responsible for mosquito breeding in waters receiving effluent from disposal plants, that nine were indirectly responsible and that 14 were not causing breeding and in one case no effort was made to clarify the sewage. This last mentioned case consists of the waste of some 200 employees of a railroad shop, plus the run-off of a large laundry. This untreated sewage runs into an open ditch some 8,000 ft. in length and finds its way to the Hackensack River. This case, however, has no bearing on the subject, as it is direct pollution.

In making our survey we covered each plant in the county and made brief notes as to conditions found. I will not attempt to discuss the findings in each case but will mention a few to give you an idea of what we have to contend with in our efforts to control mosquito breeding.

Conditions at Some of the Plants.—First: The sewage treatment plant in town A was built in 1926. It is composed of digestion and sprinkler systems sufficient in size to handle 25,800 people. The present population using the plant is 5,260. The outlet for the plant is a drainage ditch, 2½ miles in length, with no dry season flow.

At present the plant discharges effluent that is cloudy and holds large amounts of solids in suspension. In 12 months, 18 in. of solids were deposited on the bottom of the drainage ditch. This placed the drainage factor of the ditch at a minimum, and large areas, heretofore dry, were flooded with polluted water. A grave mosquito problem presented itself and the burdens of the expense placed on the mosquito commission. The seven acres of flooded meadow, in this case, supplied mosquitoes for five surrounding communities.

Second: In the town of N there is located a small lake of some 10 or 15 acres, and prior to 1925 was considered an ideal swimming pool, a place where one could linger and fish. Our inspectors, however, made weekly inspections of this lake and not until 1926 did they report any mosquito breeding. Breeding was reported throughout the season and an effort to control breeding here with oil was futile due to the width of the lake and the heavy growth of water plants. In 1927, heavy breeding was reported during the months of July and August, and we had the same trouble as the year previous. In 1928, conditions became so bad that it was necessary to open the sluice gate and drain the lake, with the result that the water which furnishes power for the mill at the lower end of the lake was unable to function for a period of three days. Due to this loss it was impracticable to ask the owner to again open the sluice when breeding re-occurred.

The pollution of this lake is caused by a sewage treatment plant located about 1½ miles further upstream.

Third: This plant was constructed in 1916 and we found little to complain of until 1926 when, due to overtaxing, heavy material was discharged from the drying beds direct to the open meadow, and in 1927, this condition became worse. In 1928 some 3 or 4 acres of meadow land was affected and heavy breeding was found throughout this area. This condition is in close proximity to several towns with a population of approximately 16,000.

Fourth: This plant is located some 1,500 ft. from the water and the effluent is run from the tanks to the creek through pipes. Due to leaks in the joints of the pipes considerable sewage is deposited over the surface of the meadow and with each high tide it is spread in all directions through a heavy growth of cat-tails. Heavy breeding is found within a 1,000 ft. of the pipe, while further away little or no breeding is found in the tide water that covers the meadows. This plant is near three large towns and we have received numerous complaints due to the prevalence of mosquitoes.

In bringing this paper to a close, I wish to demonstrate that the effluent from a plant that is overtaxed or improperly operated is a factor in mosquito control, in so far as it not only stimulates the breeding of mosquitoes in the water that receives the effluent but also tends to create new breeding places by clogging the streams with sediments and causing the water to flood adjacent lowlands.

Acknowledgment.—The foregoing is an abstract of a paper presented at the recent meeting of the New Jersey Sewage Works Association.

Treatment of Laundry Wastes

The original subsidence tank at the waste treatment plant of a laundry in Maryland was converted into an agitation and subsidence tank by placing an ordinary wagon wheel at the base of a vertical shaft so that the contents of the tank can be thoroughly stirred as the chemicals are applied to the raw method. From this tank the effluent passes to a secondary subsidence tank, thence to a cinder and gravel oxidizing bed, the overflow from which passes through a sand filter. The laundry operates three days a week and discharges approximately 1,000 gal. per hour. Studies at this plant were begun in 1927 by the Bureau of Sanitary Engineering of the Maryland State Department of Health, and were continued in 1928. According to the recently issued report of Abel Wolman, Chief Engineer of the bureau, experiments were carried on with different coagulants and at the end of the year the most satisfactory results were obtained with 7.2 grains per gallon of chlorinated copperas and 15 grains per gallon of sulphuric acid. This treatment produced a clear effluent, of a slightly greenish color, from the sand filter.

Reduction of Carbonate Hardness by Lime Softening

Results of the Excess Lime Recarbonation Process

By CHARLES P. HOOVER and JAMES M. MONTGOMERY

Chemist in Charge, Water Softening and Purification Works, Columbus, O.; Manager, Water Works, Piqua, O.

THE purpose of this paper is to describe a process by which the carbonate hardness can be reduced to the solubility limit of calcium carbonate and magnesium hydroxide.

Chemical handbooks usually record the solubility of calcium carbonate as being 13 to 20 parts per million and magnesium hydrate as being 1 part per million or, in terms of calcium carbonate, 1.7 parts per million.

These figures represent the limit to which carbonate hardness can be reduced by lime softening. In actual practical use of this process, results as low as 17 parts per million have been obtained.

The Excess Lime Recarbonation Process.—The process to be described has been in continuous use at Piqua since June, 1927, and has since been used at Columbus, Marion, Delaware, Greenville, Newark and other Ohio plants.

If lime is added in sufficient excess it will not only convert the bi-carbonates to normal carbonates, but will precipitate practically all of the magnesium salts as magnesium hydroxide. The excess lime required to precipitate the magnesium compounds to the lowest possible limit has been found at Columbus and Piqua to be that amount necessary to give the water a caustic alkalinity of approximately 40 parts per million. The caustic alkalinity or excess lime is determined on samples of water taken at the outlets of the mixing tanks. Lime softening reactions may not be entirely completed upon leaving the mixing basins and as these reactions depend largely on the temperature, the sufficiency of the dosage is more accurately determined if the samples are heated to 50° C. and filtered through paper filters before the titration for excess lime is made. After heating and filtering the sample a 100 c.c. portion is titrated with N/50 sulphuric acid, using phenolphthalein as an indicator. When the end point is reached, methyl orange indicator is added and the titration continued to the end point. Twice the alkalinity to phenolphthalein should exceed the methyl orange alkalinity by approximately 40.

The following is a typical analysis of water from the mixing tanks at Columbus and Piqua:

Total alkalinity	68
Phenolphthalein alkalinity	51
Caustic alkalinity	36

After the bulk of the precipitate has settled out, the water should be recarbonated. Montgomery* discovered that recarbonation should be continued to the point where the total alkalinity minus two times the phenolphthalein alkalinity equals approximately 5. For example:

Total alkalinity	53
Phenolphthalein alkalinity	24
Caustic alkalinity	0

If water softened and recarbonated as described is allowed a long reaction period as at the Marion, Ohio, plant, or if it is filtered through conventional type sand filters the alkalinity will drop to about the solubility limit. Recarbonated water of the above analysis filtered through the Columbus filters showed the following results:

Total alkalinity	22
Phenol alkalinity	11
Caustic alkalinity	0

The average results at Piqua in May, 1929, are shown in Table I.

The Advantage of the Process.—(1) Carbonate hardness can be reduced to practically the theoretical limit.

(2) Consistent reduction in hardness can be made irrespective of temperature.

(3) Cost of softening is reduced.

(4) Carbon-dioxide content of softened water reduced; and,

(5) Removal of magnesium according to Graf† eliminates much of the scum left in pans and bath tubs by the reaction of the water with soap.

Effect of Temperature on Process.—The reduction in carbonate hardness by this process is much less influenced by the temperature of the water than by the conventional type softening process. The following are typical results obtained at Piqua, while treating cold river water in freezing weather and relatively warm river water in the summer time (see Table II):

Cost of This Process of Removing Hardness as Compared to Removing It with Soda-Ash or by Zeolite Treatment.—During the 19 years of operation of the Columbus plant before recarbonation, the alkalinity of the softened filtered water averaged 55 parts per million with 5 parts per million of caustic alkalinity or excess lime. Very close supervision of operation is required to reduce the carbonate hardness to the theoretical solubility limit. It is not, however, especially difficult to control the process so as to reduce the carbonate hardness to say 30 parts per million. At the Columbus plant the average carbonate hardness of the filtered water during the past three months has been 30 parts per million instead of 55 parts per million as a general average over 19 years. The difference between 55 parts per million and 30 parts per million is 25 parts per million. In other words the hardness removed because of the use of the process amounts to 25 parts per million. To accomplish this 1.7 grains of additional lime are required. 1.7 grains equals 243 lb. per million gallons and at $6.71 per ton, amounts to 81 ct. per million gallons. If this hardness was not removed by the use of this process, then to meet the standard of hardness maintained at the Columbus plant, it would be necessary to remove the equivalent of this hardness with soda-ash or by the use of zeolite. To remove 25 parts per million with soda-ash at $27.62 per ton, the cost per million gallons amounts to $3.14. The saving per day, indicated by these large scale operations at Columbus, is the difference between $3.14 and 81 ct. multiplied by 30 million gallons per day, or $69.90.

To remove 25 parts per million with zeolite 0.35 lb. of salt per 1,000 grains hardness removed and salt at $6.50 per ton, the cost per million gallons amounts to $1.67. In addition to the cost of salt there would also be some extra expense for wash water.

Recarbonation Decreases the CO_2 Content of the Water.—The question is often asked: Will the addition of CO_2 gas required to recarbonate water increase its corrodibility? The answer is

*Ohio Conference on Water Purification, 7th Annual Report.

†Private communication.

Table I

	Raw	Outlet Mixing tanks	Recarbonated*	Settled	Filtered
Methyl alkalinity	145	64	70	54	22
Phenol alkalinity	0	49	30	25	9
Caustic alkalinity	0	35	0	0	0
Total hardness	165	93	98	83	52
Magnesium	20	....	....	....	2

*Water recarbonated at outlet of Dorr Clarifier ahead of settling basins.

Table II

Jan. 1, 1928
Water Temperature, 38° F.

Raw Water		Filtered Water	
Total alkalinity	119	Total alkalinity	22
Total hardness	145	Phenol alkalinity	9
Magnesium	15	Total hardness	54
		Magnesium	2

June 14, 1929
Water Temperature, 72° F.

Raw Water		Filtered Water	
Total alkalinity	187	Total alkalinity	20
Total hardness	210	Phenol alkalinity	9
Magnesium	20	Total hardness	48
		Magnesium	2

no, unless not applied as hereinbefore related. There is less carbon-dioxide in the water so softened than in uncarbonated softened water as previously softened at municipal water softening plants. That is of course not true where the excess lime and soda treatment is practiced as by railroads and industrial plants.

To explain why there is less free CO_2 in overtreated recarbonated water than in ordinary softened water without recarbonation, it is necessary to explain that CO_2 may exist in water in three forms. Free, half-bound and bound. For example: The average alkalinities of the filtered water at Columbus, for the past 19 years were as follows:

Total alkalinity	55
Phenolphthalein alkalinity	30
Caustic alkalinity	5

This water contained CO_2 as follows:

Free CO_2	0
Half-bound	0
Bound	22
Total	22

The softened recarbonated water at Columbus on March 24, 1929, using excess lime followed by recarbonation shows CO_2 as follows:

Free Co_2	0
Half-bound	.9
Bound	10.1
Total	11.0

In other words, the second analysis on recarbonated water shows only half as much CO_2 as the first analysis of water which was not recarbonated.

Disadvantages of Process.—Recarbonation was developed for the purpose of stabilizing lime softened water.

Filter sand incrustation, deposits in mains and meters in Columbus has already been described.**

The question now arises: Have the benefits of recarbonation as originally used been lost by using it as herein described?

In so far as the operation of the filters is concerned it has.

Effect of the Process on Sand Filters.—As shown by the results given, from 25 to 30 parts per million of hardness is removed by being deposited on the filtered sand. In time the sand grains will become incrusted just as they did formerly at water softening plant before recarbonation was developed. Judging from the rate of growth of the filter sand at Piqua, unless some means of removing the incrustation is employed, it would probably be necessary to replace the sand after about 10 years of operation. It is estimated, however, that even if the sand has to be renewed in ten years, it is still economical to use the process because the saving in softening chemicals will more than pay the cost of sand replacement.

Although the water incrusts the sand grains, the water leaving the filters is apparently stable. After two years of operation at Piqua, several taps were made in the water mains and no incrustation was visible. A number of meters were removed for examination and no deposits were found.

At Delaware, O., where this process is being used and where there is already incrustation in the distribution system, a second dosage of carbon-dioxide is applied to the water after filtration. The purpose of this additional carbon-dioxide is to make the water sufficiently corrosive to dissolve some of the carbonate already in the mains.

Schemes Being Tried to Throw the Burden Off the Filters.—Various methods of removing this burden from the filters are being tried. At Piqua the incrustation has been removed successfully by taking the filter out of service after two or three months' use and then allowing the highly acid water from the carbonation scrubber to flow up through the sand and out through the wash water troughs. After two or three weeks of this treatment the incrustation has been dissolved and the filter is again ready for service.

The calcium carbonate formed by the recarbonation in this method of treatment will crystallize out and settle if sufficient settling time is provided. Tests to determine the minimum time are now being made.

Experimental results indicate that the reaction will go to completion much more rapidly if the softened water is agitated after being recarbonated.

Return of sludge, the addition of coagulating materials and filtration through coarse filtering materials are some other schemes that are receiving attention.

Acknowledgment.—The above is an abstract of a paper presented June 27 at the 49th annual convention of the American Water Works Association.

**Journal of Industrial and Engineering Chemistry. Volume 19, July, 1927.

Piecemeal City Planning

In spite of the rapid development of city planning one of the shortcomings of American municipalities is found to be the lack of a comprehensive plan, by Gardner S. Rogers, city planning expert, Assistant Manager of the Civic Development Department of the Chamber of Commerce of the United States.

"Proper municipal development," he said in an address to the Southern Commercial Secretaries' Association, "is not a series of unrelated projects developed when demanded by necessity or political expediency, but rather one comprehensive project in which each individual part has a definite relation to the whole.

"The builder of an office building would not complete the structure and later tear down walls and partitions to add the necessary plumbing and lighting fixtures, yet many cities lay concrete pavements to be torn up later for the purpose of extending or enlarging water or sewer mains. A large office building would not be located on a farm two miles from the center of population because farm land was less expensive than city property, but school boards have a habit of choosing inexpensive sites on the outskirts of a town and so far from the children that bus lines must be established to collect them.

"Comprehensive city planning as it is understood today is the foundation of all municipal improvement and when properly executed coordinates all phases of municipal work in one comprehensive whole. Such a plan may be divided into four major divisions; thoroughfares, zoning, recreation and the platting of undeveloped property."

City Building

Cities that are allowed to grow wild without regard to the uses made of them are rapidly diminishing in number, it is asserted by the Civic Development Department of the Chamber of Commerce of the United States.

In a publication on "Zoning," which has just been issued, it points out that although zoning did not begin in this country until 1916, when New York adopted the first zoning ordinances, the practice is now almost universal.

"Today," says the foreword to the Chamber pamphlet, "this conception of zoning is understood in nearly every city and village in the country. In less than 15 years more than 700 municipalities have been zoned.

"The present problem, therefore, is not so much one of education as it is one of procedure. What does a zoning ordinance contain? To what extent does it regulate property, and how are these regulations put into effect? How are safeguards provided for so that injustices to property owners will be eliminated? These and other practical questions are here discussed in outline form."

Micro-organisms in the Lake Michigan Water at Chicago

Their Effect on Filtration and Method for Counting

By JOHN R. BAYLIS and H. H. GERSTEIN
Bureau of Engineering, Chicago, Ill.

A RECORD of the Plankton in the Lake Michigan water at Chicago was thought to be of some value in determining how long each year we may expect short filter runs when the filtration plants are constructed. The Division of Water Safety Control, Bureau of Engineering, has collected samples from the various intake tunnels for microscopical counts during the past several years. The counts have been made at the Chicago Department of Health. At first samples were collected five times each week, but now they are collected only three times weekly. Since starting operation of the experimental filtration plant, microscopical test of the water from the Dunne crib have been made at this plant in addition to those made by the Health Department.

Fairly reliable record of the organisms occurring in the water entering the Chicago intake cribs for the past two years is now available. The prevailing class of organisms is diatoms, the other algae may occur in abundance occasionally. The monthly average of the volume of all organisms is shown in Fig. 1. It will be noted that the peak for 1927 was in May and for 1928 it was in September. It is interesting to note that in 1928 the minimum monthly average was nearly one-half the maximum. It probably is unusual for water in the northern part of the United States to have a January and December volume of organisms of about 500 cubic standard units per cc. (a cubic standard unit is a cube 20x20x20 micra). The temperature of the water is shown in Fig. 2, and the hours of sunshine are shown in Fig. 3.

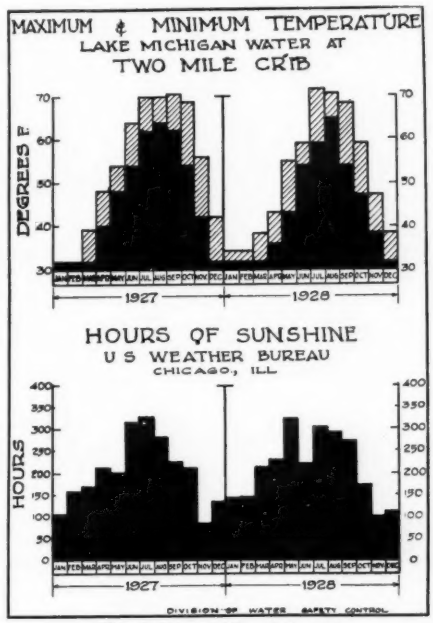


Fig. 2 Upper, Fig. 3 Lower

Figures 4, 5, 6, 7, 8 and 9 show the monthly averages of the 6 organisms occurring in fairly large numbers. It will be noted that Tabellaria may grow abundantly at most any season of the year. It was high from April, 1927, to February, 1928; also high again in October, November and December, 1928. Asterionella usually has its peak in the spring. The peak for Fragillaria seems to occur at most any time of the year. Nitzchia and Melorira usually have their peaks in the spring. Dinobryan, and perhaps most animal organisms, usually have their peaks in the summer or fall. It will be noted from Table I that no animal organism occurring in fairly large number had its peak in the espring. It also will be noted from Table I that the day of highest volume usually occurred in the spring or summer for the diatoms and in the latter part of the year, from August to December, for the green algae. The counts at the experimental plant correspond fairly well with the counts made by the Health Department.

Tastes and Odors. — Objectionable tastes and odors have not occurred in the Chicago water as often as might be expected from the large number of organisms present. There seems to be no reliable information as to how many organisms of the taste-producing kind are necessary to impart a taste to water. If there are 200 or 300 cubic units of a certain organism present we have little information as to whether this is near the taste-producing point or whether the water may contain many more without danger of taste or odor. The writers therefore can give very little information along this line.

There have been several periods during the past few years in which there were tastes readily noticeable in the Chicago water. The following is taken from the 1926 report of the Division of Water Safety Control:

"Beginning about the first of July, 1926, and continuing for over three weeks there was a marked grassy to objectionable fishy taste in the public water supply throughout the city. The cooperation of the U. S. Public Health Service was enlisted in studying the cause of this condition. Assistant Limnologist Milton S. Foreman, attached to the Stream Pollution Office of that service at Cincinnati, O., was detailed by the Surgeon General on July 15 to assist in the investigation. The most offensive condition existed between July 7 and 10, during which time hundreds of complaints were received from citizens in all sections of the city. Continuing throughout the summer, and even as late as the first week in Sep-

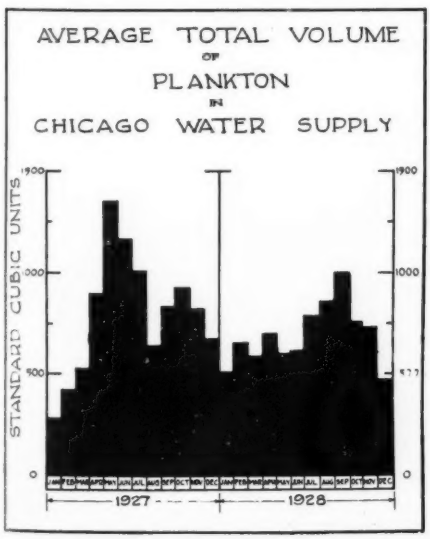


Fig. 1

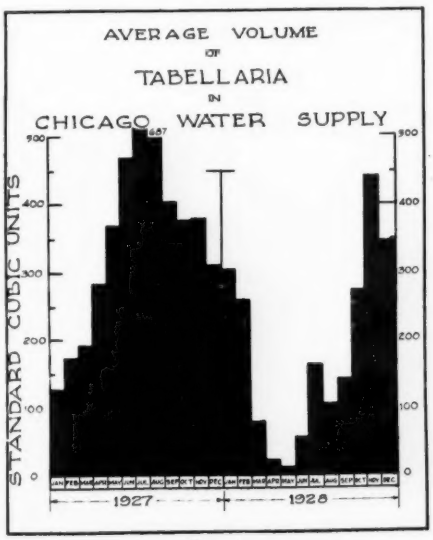


Fig. 4

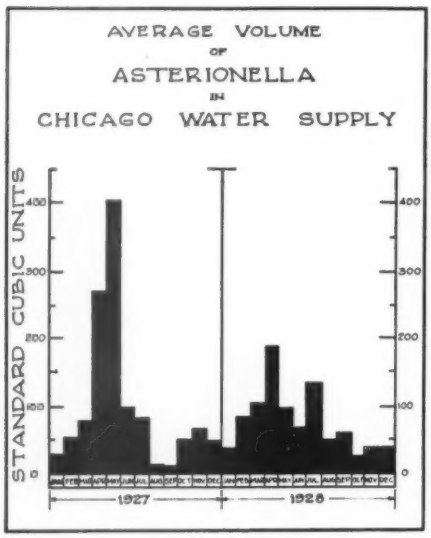


Fig. 5

tember, a noticeable grassy to fishy taste persisted in the water supply."

The microscopical counts during the days of excessive taste showed the presence of about 250 cubic units of Dinobryan per cc. At this time the entire volume of the cluster of organisms was measured, consequently the volume given was greater than the true volume.

The 1927 and 1928 reports each record a period of taste. "There was a noticeable fishy taste in the water in July, 1927, and in the early part of August, which was attributed to the presence of large numbers of Tabellaria." From the 1928 report there is the following: "During the first few days in July a taste was noticed in the water supply which was probably caused by the marked increase in Dinobryan."

Effect of Micro-organisms on Filtration.—It is not necessary to tell most filter operators that microörganisms cause a shortening of the filter runs, for this is the most serious operating trouble in many plants. Many perhaps are already familiar with how the organisms actually cause short filter runs, but there is little specific information in the water works literature on the subject. One of the writers (Baylis) has made observations for a number of years on the things that affect filter runs, which, it is hoped, will throw a little more light on the subject.

First we should consider how a sand filter actually removes the suspended matter from water. In this paper the discussion will be limited to water that has been coagulated as is customary practice in rapid sand filtration. It is evident that the voids in the sand bed of a rapid sand filter are much larger than many of the particles of coagulated matter, yet all the particles are filtered out without difficulty. This is due largely to a lodgement of the particles in the wedge of the void where two sand grains touch. Ordinarily there is considerable penetration of the coagulated matter into the sand beds when sand of about 0.3 mm. diameter or larger is used. This is what we hope to accomplish, for when the filtration is largely on the surface of the sand bed the loss of head increases very much more rapidly than if the coagulated matter penetrated into the bed. Figure 10 shows typical loss of head curves where there is penetration into the bed and where the filtration is largely in the surface of the bed. It will be noted that the curve when there is penetration is nearly straight whereas the one where the filtration is largely in the surface layer the curve keeps increasing at an accelerated rate.

Certain microörganisms add toughness to the coagulated matter. It is somewhat like adding steel reinforcing to concrete. As the coagulated matter filters out it forms a mat on top of the sand bed so tough that the increasing pressure to keep the filtration rate

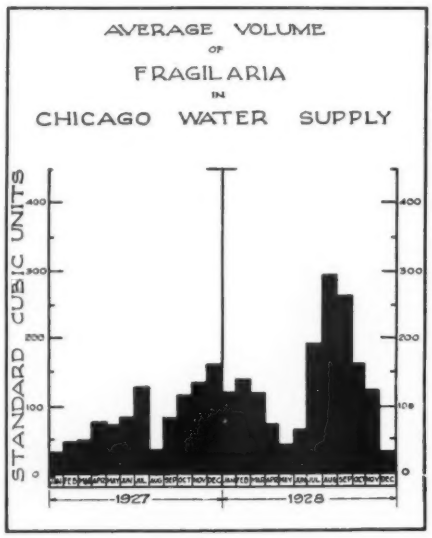


Fig. 6

constant does not force it through the voids in the sand at the surface as is the case where no organisms are present. Figure 12 shows camera lucida drawing of coagulation containing entrapped microörganism, and Fig. 13 shows the more compact mat formed on the filter surface. It is evident that the mat actually formed at the filter surface is much thicker than that shown by Fig. 13, but a thin section that would allow light to pass through had to be used for making the drawing. The mat will vary in toughness with the kind of organism present. Long filamentous organisms are more effective in adding toughness to the coagulated matter than the short or spherical organisms. In most instances when extremely short filter runs occur filamentous organisms are the main cause, however an enormous increase of certain organisms like Asterionella or Tabellaria may cause very short runs.

There are instances where spherical or nearly spherical organisms have been thought to be the cause of the short runs. Some organisms of this kind appear to break up and form a gelatinous substance in the water that is much tougher than the gelatinous precipitate of alumina or iron. There are also instances where a comparatively small volume of the organisms reach the filter beds, yet the runs are short. This is believed to be due largely to the presence of gelatinous matter that results from the decay or breaking up of the organisms back in the reservoir before the water reaches the filtration plant.

There are two ways in which filter runs may be lengthened when microörganism are the cause of the short runs. The organisms must be removed before the water reaches the filter beds, or the water must be filtered through a bed of coarse material before going to the main sand filters. It might be possible to add a few inches of light coarse material on top of the sand and produce somewhat the same results as double filtration. The coarse material should contain voids large enough that a mat cannot form on the surface, yet it must be capable of removing a large percentage of the coagulated matter.

It is believed that sedimentation offers the most practical means of removing microörganisms in most instances. Where the water goes through storage reservoirs of several days capacity prior to chemical treatment and filtration, chlorine or copper sulphate may be used to kill the organisms. Then many of them will gradually settle to the bottom. When it is not possible to do this and it is necessary to take the water as it comes to the plant a quick settling flocculation must be produced. This may be done by adding suspended matter to the

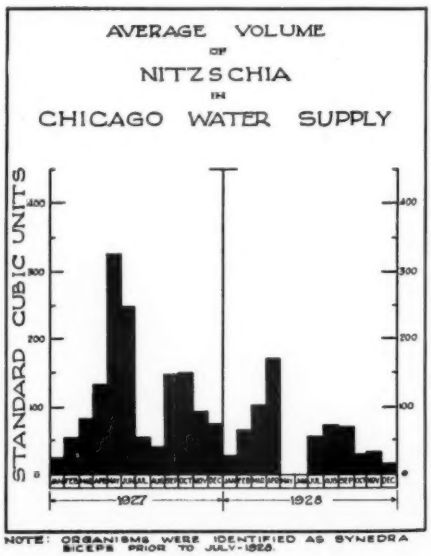


Fig. 7

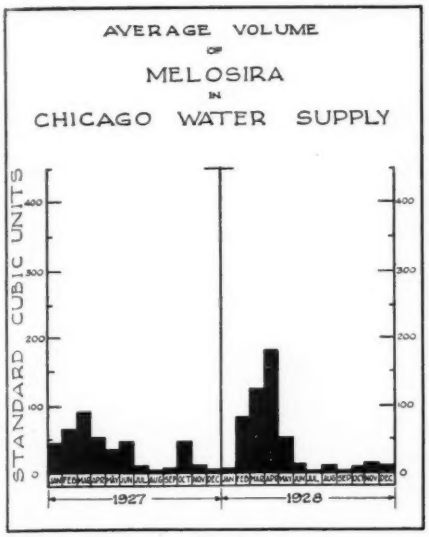


Fig. 8

water as Lovejoy[1] has done at Louisville by the addition of an excess of coagulant, or the production of an artificial turbidity by softening with lime. Local conditions will largely determine the most effective means of handling the situation. The point that should be stressed is that all plants subject to short filter runs should be prepared to handle the situation in some manner and not let the filtration plant operate at decreased efficiency part of the time.

Most of the plants handling the Great Lakes waters are troubled with microörganisms producing short filter runs part of the time. Usually a storage reservoir of a few days capacity separate from the lake is not provided. The organisms probably can be handled best by precipitating them with the coagulated matter. The organisms themselves have very little tendency to settle, or they would not be in the water. Aluminum hydroxide coagulation also is very light and does not settle rapidly even though an excess is used. To produce a rapidly settling coagulation there must be an increase in the turbidity. This may be done by adding mud to the water, or by forming a crystalline precipitate in the water. The fact that the Great Lakes water is fairly hard and is already saturated or nearly saturated with calcium carbonate, it seems that the most economical thing to do is to add lime to the extent of producing a calcium carbonate precipitate that will increase the turbidity to 50 or more.

Method for Counting.—The Chicago Health Department laboratory uses the procedure as outlined in Standard Methods of Water Analysis, except that coarser sand is used for filtering the water. This is due to the difficulty in filtering through the desired amount of the sample within a reasonable time. To avoid this trouble and to eliminate the error in concentrating, the experimental filtration plant makes a direct count without concentrating unless the counts are very low. This procedure will be outlined.

[1]Lovejoy, W. H. Algae control by creating turbidity at Louisville, Ky. Engineering News-Record, Vol. 101, No. 14, Oct. 4, 1928, pp. 505-507.

Table I—Micro-organisms in Chicago Water Supply, 1927-1928

Organisms	Maximum Monthly Average of All Cribs Cubic Std. Units	Date	Maximum Daily Occurrence Cubic Std. Units	Date	Crib
Diatoms—					
Tabellaria	687.4	July, 1927	1452	June 22, 1927	4-Mile
Asterionalle	403.8	May, 1927	1710	May 12, 1927	Harrison
*Nitzchia	328.3	May, 1927	798	May 23, 1927	Wilson
Fragilaria	293.5	Aug., 1928	846	July 23, 1928	Harrison
Melosira	181.5	Apr., 1928	840	Apr. 25, 1928	2-Mile
Synedra	133.9	May, 1927	378	June 1, 1927	Harrison
Rhizosolenia	63.3	June, 1927	342	May 26, 1927	Wilson
Unknown No. 1	43.6	May, 1928	156	Mar. 13, 1928	Wilson
Diatoma	23.5	Aug., 1928	158	Oct. 1, 1928	4-Mile
Amphiprora	13.4	Aug., 1928	210	Aug. 31, 1928	Dunne
Stephanodiscus	12.6	Aug., 1928	101	Aug. 3, 1928	Wilson
Cyclotella	11.5	Apr., 1928	72	Mar. 14, 1927	Dunne
Surirella	9.3	July, 1928	132	Sept. 5, 1928	Dunne
Pleurosigma	8.2	Aug., 1928	60	Aug. 24, 1928	Harrison
Navicula	5.7	Mar., 1928	102	Feb. 23, 1928	Harrison
Amphora	4.7	Nov., 1928	60	July 27, 1928	2-Mile
Epithemia	3.1	Mar., 1928	150	June 27, 1928	Wilson
Cymatopleura	1.8	Oct., 1927	18	Oct. 10, 1927	Harrison
Green Algae—					
Ulothrix	18.8	July, 1928	121	Aug. 8, 1928	Dunne
Spirogyra	10.1	Sept., 1927	96	Sept. 12, 1927	4-Mile
Merismopedia	7.2	Nov., 1927	150	Nov. 2, 1927	4-Mile
Coelosphaerium	6.0	Oct., 1927	600	Oct. 21, 1927	Wilson
Pediastrum	5.1	Nov., 1928	300	Nov. 10, 1928	Harrison
Dimorophococcus	2.6	Nov., 1927	180	Jan. 5, 1928	4-Mile
Anabaena	2.5	June, 1927	60	June 30, 1927	2-Mile
Dictyosphaerium	2.3	Oct., 1927	150	Nov. 3, 1927	Wilson
Protococcus	1.3	Jan., 1928	72	Dec. 8, 1927	Harrison
Gloeocystis	1.2	Jan., 1928	90	Jan. 27, 1928	Harrison
Actinastrum	.9	Dec., 1928	42	Dec. 4, 1928	Harrison
Ankistrodesmus	.5	Oct., 1927	30	Oct. 14, 1927	4-Mile
Staurastrum	.3	Sept., 1928	18	Sept. 26, 1928	Wilson
Chroococcus	.2	Nov., 1927	18	Nov. 15, 1927	4-Mile
Myxonema	.1	May, 1927	10	May 20, 1927	4-Mile
Desmidium	.01	Jan., 1927	1	Jan. 1, 1927	Wilson
Protozoa—					
Dinobryon	135	Oct., 1927	522	Nov. 1, 1927	Wilson
Ceratium	58.6	Sept., 1927	540	Oct. 5, 1928	4-Mile
Vorticella	10.7	Dec., 1927	1008	Dec. 16, 1927	Harrison
Acineta	10.5	Oct., 1928	732	Oct. 1, 1928	Wilson
Difflugia	5.8	Aug., 1928	90	Aug. 29, 1928	Dunne
Synura	3.8	Nov., 1927	72	Nov. 25, 1927	Harrison
Uroglena	3.0	Sept., 1928	96	Oct. 31, 1927	Dunne
Nassula	1.1	Aug., 1928	72	Aug. 17, 1928	Wilson
Carchesium	.9	Sept., 1927	4	Oct. 6, 1927	Wilson
Amoeba	.8	May, 1927	24	June 8, 1927	Harrison
Glenodinium	.7	Sept., 1928	18	Sept. 12, 1928	Dunne
Actinophrys	.3	Nov., 1927	24	Nov. 16, 1927	4-Mile
Mallamonas	.2	July, 1928	14	July 17, 1928	Dunne
Rotieera—					
Anuraea	96.9	Sept., 1928	900	Aug. 27, 1928	Wilson
Polyarthra	89.8	Aug., 1928	1680	Aug. 31, 1928	2-Mile
Brachionus	5.3	Sept., 1928	240	Sept. 21, 1928	Harrison
Diaschiza	2.6	Sept., 1928	144	Sept. 19, 1928	Dunne
Crustacea—					
Cyclops	115.8	Sept., 1928	3972	July 25, 1928	Harrison
Daphnia	109.1	Sept., 1928	1200	Sept. 24, 1928	2-Mile
Bosmina	32.1	July, 1928	1884	July 28, 1928	Harrison
Coelenterata—					
Hydra	125.7	Oct., 1928	8800	Oct. 24, 1928	Harrison
Aquatic earthworms	201.0	May, 1928	90	July 15, 1927	Wilson
Aquatic roundworms	.5	June, 1927	48	June 2, 1927	Dunne

* Prior to May, 1928, Nitzchia was identified as Synedra biceps.

For counting the small organisms, 1 cc. of the water is placed in a Rafter's counting cell and allowed to stand about 10 minutes before starting the count. Practically all the organisms settle to the bottom of the cell within this time. There are a few species that float and will come to the top of the cell, but such organisms are rarely present in most waters. The count is made by focusing the microscope on the bottom of the cell and starting at one end. The cell is moved gradually towards the other end with the mechanical stage and the organisms are counted and measured as they are passed over by the ruled portion covered by the eyepiece micrometer. This should be repeated across the cell until a sufficient number of organisms have been counted to give fairly good indication of the number present. In addition to this it is desirable to go across the cell a few times with the focus at the top so that floating organisms will not be missed. If the magnification is such that the ruled

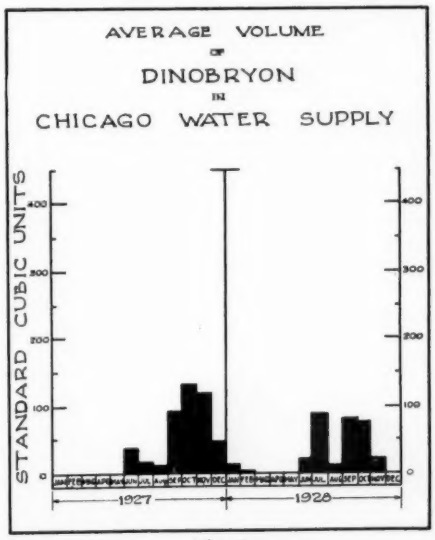
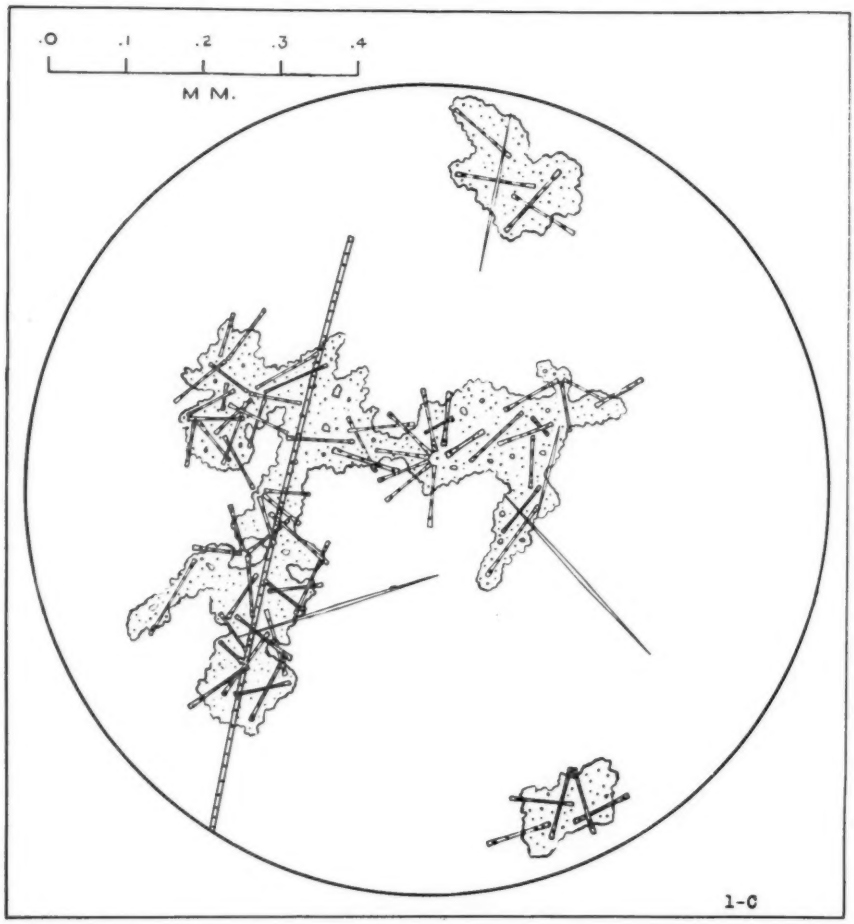


Fig. 9

Table II—Comparison of Direct Count with Samples Concentrated by Filtration

Date	Direct Count		Concentrated by Filtration	
	No. of organisms per CC.	Cubic standard units per CC.	No. of organisms per CC.	Cubic standard units per CC.
8-31-28	676	184	306	149
9- 6	276	113	378	91
9-25	465	236	420	136
9-27	1,010	429	570	175
9-28	785	303	845	438
10-1	656	261	486	212
11-21	1,690	273	1,350	565
1-25-29	310	230	240	115
1-30	201	116	240	80
1-31	140	136	210	87
2-1	248	181	372	280
2-7	292	126	180	99
2-14	212	119	444	211
2-27	340	146	300	108
2-28	220	90	372	141
3-1	389	315	300	58
3-6	640	227	450	137
3-8	540	226	516	128
3-15	128	44	240	117
3-19	335	170	324	61
3-21	368	83	246	64
3-22	241	105	348	130
3-27	449	122	366	150
3-28	449	174	222	113
3-29	550	273	126	43
4-2	1,320	416	1,764	877
4-4	285	194	480	94
4-9	666	175	510	113
4-10	690	185	702	221
4-11	1,040	282	1,008	256
4-16	4,160	886	2,976	658
4-17	4,220	810	3,120	571
4-18	5,580	1,279	4,224	826
4-23	3,520	796	3,240	713
4-24	5,700	1,130	4,040	688
4-25	6,050	1,150	5,400	1,060
4-26	5,050	1,090	2,840	592
Average	1,351	353	1,085	285

portion covers one square millimeter, passing from one end of the cell to the other (the cell is 20 mm. wide and 50 mm. long) is one-twentieth of a cc. When the counts are high, passing across the cell once may be sufficient, but when only a few are present it may be necessary to examine the entire cc. of water. In fact when there are less than 25 organisms present the samples should be concentrated.



MICROÖRGANISMS ENTANGLED IN ALUMINUM HYDROXIDE COAGULATION
Fig. 12

The examination for large organisms is made by concentrating and examining in a 10 cc. cell. This cell is 50 millimeters long, 40 millimeters wide, and 5 millimeters deep, inside dimensions. It is constructed in the same manner as the Rafter's cell. Instead of filtering the water through sand No. 20 silk bolting is used, being made in the form of a cylinder about 4 in. long and ½ in. in diameter. This is attached to the bottom of the filtering funnel and the desired amount of water filtered through. The water passes through the cloth quite rapidly and most any amount desired may be filtered within a very short time. When a large number of large organisms are present 2 to 5 liters are filtered.

After the water has filtered through, the plug on the bottom of the cloth cylinder is removed and the catch washed through with slightly less than 10 cc. of water. It is then diluted to 10 cc. and placed in the large counting cell. The 48 mm. objective is used and the procedure for counting and estimating the volume is the same as for the small cell, except there is a different factor for the area covered by the ruled portion. It may be necessary to kill the organism to prevent them from moving about while the count is being made. As a rule only such organisms as measure about 150

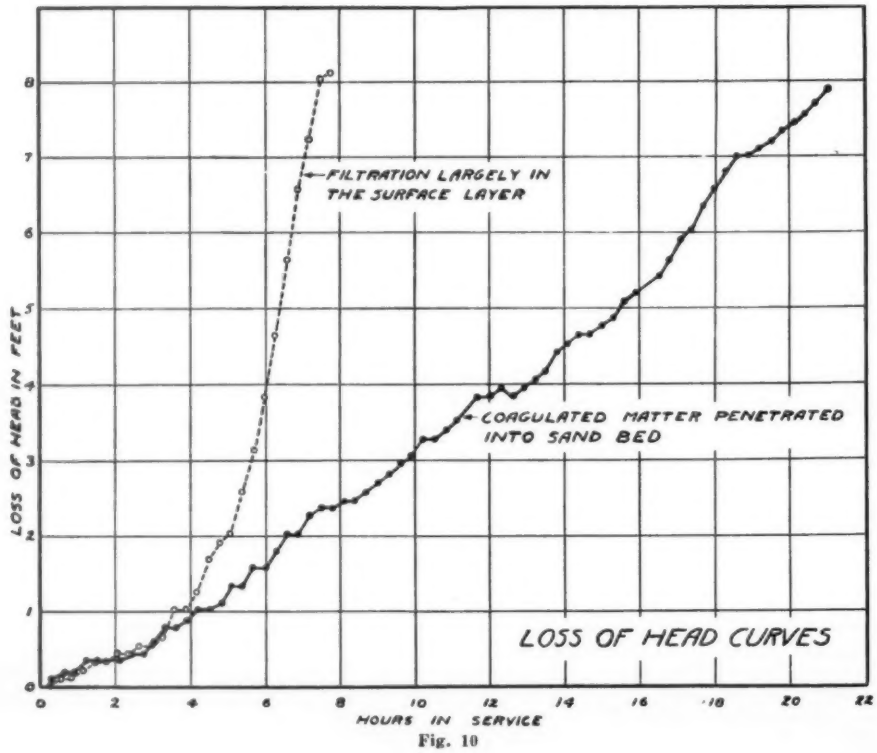


Fig. 10

Table III—Volume of Organisms in Cubic Standard Units

Diameter in micra	Spherical	Cylindrical 100 micra in length
1	.000	.01
2	.001	.04
3	.002	.09
4	.004	.16
5	.008	.25
6	.014	.35
7	.022	.48
8	.033	.63
9	.048	.80
10	.065	.98
11	.087	1.19
12	.113	1.41
13	.143	1.66
14	.180	1.92
15	.221	2.21
16	.268	2.51
17	.322	2.84
18	.382	3.18
19	.449	3.54
20	.524	3.93
22	.697	4.75
24	.905	5.65
26	1.150	6.64
28	1.437	7.70
30	1.767	8.84
32	2.141	10.05
34	2.572	11.35
36	3.054	12.17
38	3.591	14.17
40	4.189	15.71
45	5.964	19.88
50	8.181	24.54
60	14.144	35.34
70	22.449	48.11
80	35.510	62.83
90	54.257	79.52
100	65.449	98.17

To obtain the volume of organisms with diameters larger than is shown by the table, look for the volume one-tenth the diameter and move the decimal point three places to the right for spherical organisms and two places for cylindrical organisms.

micra or more in diameter are counted. This will include Daphnia, Cyclops, Hydra, Bryozoa, large protozoa and rotifiers, worms, etc. Daphnia and Cyclop frequently occur in numbers that cause a shortening of the filter runs, yet the procedure as outlined in Standard Methods of Water Analysis does not insure an accurate estimate of the number and volume of such organisms. The method of concentrating by filtering through cloth was developed by John H. Mills, bacteriologist at the experimental plant.

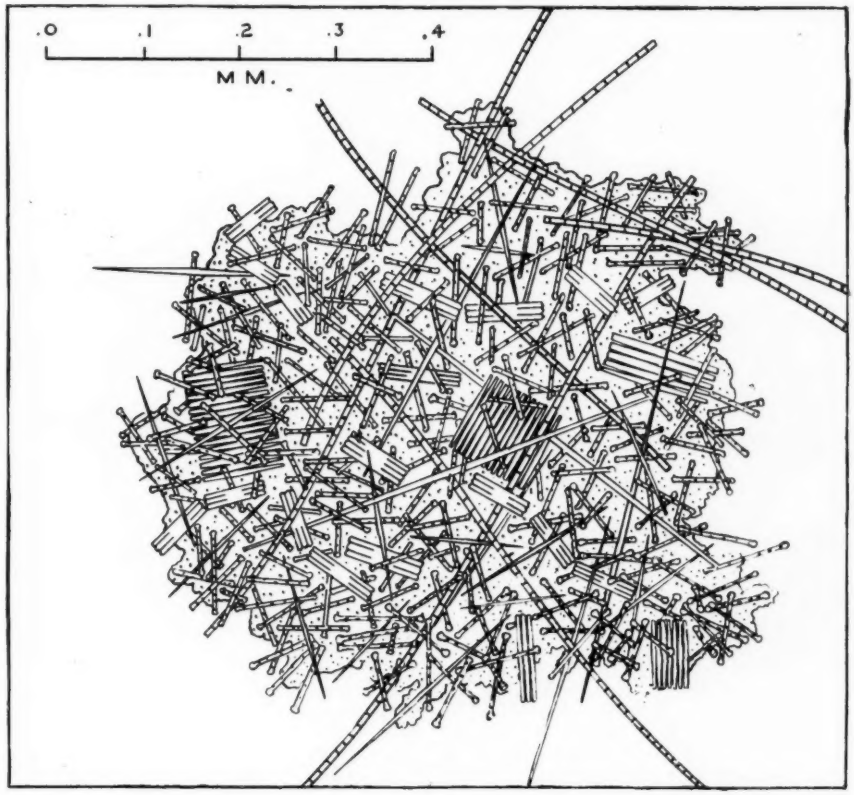
One of the writers (Baylis) has used the direct method of counting for a number of years and prefers it to concentrating the samples. It is more accurate and usually involves less labor than the concentration method. Table II shows comparison of the direct count with the concentration method as outlined in Standard Methods. It is seen that the direct count gives a slightly larger number of organisms.

It is believed desirable to state how the measurements of the organisms are made, especially as there seems to be no uniform procedure for such measurements and different workers may vary greatly in the volume measurement for certain species of organism. Some workers will take the entire area within the circle of a characteristic spoke-wheel cluster of Asterionella cells, whereas the actual volume is the sum of the volumes of the individual cells. A cluster of Dinobryon is sometimes measured as the outside dimension of the cluster, yet it is evident that the true volume is that of the cells only. With the various procedures now used it is difficult to compare the results from two laboratories. The procedure as used by Baylis will be given.

The volume in cubic standard units for various size organisms is given in Table III. It provides for measuring the organism as a sphere or cylinder. If the organism is nearer a sphere than a cylinder its spherical diameter is estimated and the volume obtained directly from the table. If its length is considerably greater than the diameter it is measured as a cylinder. The length and diameter are determined and the column for cylindrical organism used. The figures are based on a cylinder 100 micra (0.1 mm.) in length. The volume is quickly computed from the table but is not given unless the length happens to be 100 micra. Assume that an organism is 150 micra in length and the average diameter is 12 micra. The table gives 1.41 cubic standard units for the volume of an organism this diameter 100 micra in length, consequently the total is 2.17 units.

Such organisms as occur in clusters that are easily broken apart are counted one organism for each cell. This includes Asterionella, Dinobryon, Fragellaria, Synedra, Bryozoa, and others. Organisms that occur in filaments such as Melosira, Oscillatoria, Anabaena, Aphanizomenon, Ulothrix, and many others are called one organism per 100 micra of length. A melosira 800 micra in length is recorded as 8 organisms.

A record sheet as shown in Fig. 14 is used. The advantage of this kind of a record becomes apparent. Assume that there are 8 attached cells to a cluster of Asterionella. Eight is recorded as a numerator, and the total volume of the eight cells is recorded as the denominator. One can tell from the sheet just how the Asterionella occurred, for when there is an individual cell it is recorded as one and when there are two or more attached the number is recorded. Such a system of recording is advantageous for recording Asterionella, Fragillaria, Tabellaria, Dinobryon, and in fact all organisms that may occur either single or in clusters. It is particularly advantageous for filamentous organisms, for the length of the filament may be obtained from the record. Assume a filamentous organism is recorded 7.5 organisms and 15 cubic standard units. The organism is 750 micra in length and 15 micra in diameter. The length of the filament has considerable bearing on its effectiveness in causing filter clogging. In studying operating records one may refer to the original sheets and determine the size of all organisms counted.



COMPACT ALUMINUM HYDROXIDE COAGULATION CONTAINING MICROÖRGANISMS.
Fig. 13

Acknowledgment.—The foregoing is

MICROSCOPICAL COUNT

	1 CC.	10 CC.
OBJECTIVE	16 MM.	48 MM.
PORTION EXAMINED	1/10 CC.	10 CC.
CONCENTRATION	0	500
FACTOR	10	.0002

DATE JUNE 21, 1928
SAMPLE TUNNEL FROM DUNNE CRIB
EXPERIMENT No. 11
COUNT BY JOHN H MILLS

COUNT ON 1 CC. CELL

ORGANISM	MEASUREMENT	NUMBER	CUBIC UNITS
ASTERIONELLA	7/1.4 8/1.6 1/.2 1/.2 1/.2 3/.9 1/.2 3/.9 1/.2 2/.4 8/14 1/.2 3/.9 3/.6 6/1.8		
	5/1.0 2/.4 3/.6 1/.2 2/.4 2/.6 6/12 2/.4 1/.3 2/.4 1/.2 5/12 — — —	81	18.0
SYNEDRA	1/.3 1/.2 1/.1 1/.1 1/.1 1/.8 1/.2 1/.2 1/.1 1/.2 1/.2 1/.1 1/.2 1/.2 1/.2		
	1/.3 1/.2 1/.2 1/.3 1/.2 1/.2 1/.2 1/.1 1/.3 1/.3 — — — — —	25	5.7
MELOSIRA	2/1.6 25/200 — — — — — — — — — — — — —	27	21.6
FRAGILLARIA	3/.5 3/4 — — — — — — — — — — — — —	6	.9
CYCLOTELLA	1/.1 1/2 — — — — — — — — — — — — —	2	.3
NITZSCHIA	1/3.0 — — — — — — — — — — — — — —	1	3.0
NO. 1	1/1.0 — — — — — — — — — — — — — —	1	1.0
	— — — — — — — — — — — — — —		
	— — — — — — — — — — — — — —		
	— — — — — — — — — — — — — —		
	— — — — — — — — — — — — — —		
	— — — — — — — — — — — — — —		
	— — — — — — — — — — — — — —		
	— — — — — — — — — — — — — —		
UNCLASSIFIED	1/.1 1/1.6 1/.1 1/.3 — — — — — — — — — —	4	2.1
	TOTAL	147	52.6
	TOTAL PER CC.	1,470.	526.

COUNT ON 10 CC. CELL

ORGANISM	MEASUREMENT	ORGANISM	MEASUREMENT		
CYCLOPS	1/4000 1/4000 1/4000 1/4500	DAPHNIA	1/1800 1/1600 — —		4.0
	— — — —		— — — —		
			TOTAL PER CC.	1,470	530

Fig. 14

an abstract of a paper presented at the 49th annual convention of the American Water Works Association, held June 24-28 at Toronto, Ont.

Snow Melted in Cooling Pond of Power Plant

The city of Westmount, Que., melts the snow gathered from the city streets and walks in the cooling pond of the municipal power plant. The pond was built for the purpose of cooling hot water from the condensers of the steam plant. To facilitate the melting of the snow, which is dumped from the trucks in which it is collected, steam lines are carried directly from the boilers to the pond where they discharge below the dumping space provided for the trucks. About 40 per cent of this steam is derived from the destruction of garbage and if the heat units so obtained be disregarded, the average cost of melting snow is less than 20 ct. per load of about 9 cu. yd.

Training Schools for New York State Municipal Employees

A comprehensive program for the training of all groups of municipal officials and employees was adopted at a recent meeting of the Advisory Committee of the Conference of Mayors and Other Municipal Officials of the State of New York.

According to the Boston City Record, ten years will be required for putting into effect the complete schedule, which calls for the establishment of training facilities for health, fire, charities and financial officials, civil service employees, water bureau superintendents, purchasing agents, city and village clerks, park officials and assessors.

The conference has plans already under way for the training schools for fire department and charties department employees similar to those now being organized for police training, and the training of health officers is being taken care of by the State Health Department.

Venturi Meter Regulates Flow of Coagulant

A Venturi meter performing a dual role is an interesting feature of the new Huia filter station at Auckland, New Zealand. Water is carried to the filter station by a concrete aqueduct designed for a capacity of 32 m.g.d. The conduit terminates in a Venturi tube having an upstream diameter of 4 ft. 6 in. and a throat diameter of 17 in. In addition to metering the flow, the Venturi serves as a part of the coagulant dosing apparatus.

The upstream end and the throat of the Venturi meter are connected by piping to vertical concrete tubes, in which are placed copper floats. The difference in elevation of the floats is, of course, proportional to the flow through the meter, and this difference is made to control the rate at which the coagulant is admitted. The relative movement of the floats is translated into a vertical movement of a hollow arm. This arm is hinged at its lower end, is fitted with an adjustable orifice at its upper end and is connected to the tank containing the coagulant solution. The solution in the tank is kept at a constant level by means of floats. When there is no flow through the Venturi, the orifice is at the level of the solution and there is no flow of coagulant. As the flow of water increases, the orifice drops an amount proportional to the difference in head between the throat and the upstream face of the Venturi and the dose of coagulant is thus kept constant at all times.

Atlantic City's $15,000,000 Municipal Auditorium Inaugurated.—The recently completed $15,000,000 municipal auditorium of Atlantic City, N. J., was inaugurated with the convention of the National Electric Light Association, in which was staged the largest exhibition of electrical equipment ever assembled under one roof. This convention marks the beginning of the Edison Jubilee, which continues until October.

New York City to Have More Parks.—The Board of Estimate of New York City has authorized the purchase at private sale of prospective park sites in Queens and Richmond with a combined plottage of more than 632 acres at a cost not exceeding $2,250,000, from the $3,000,000 fund recently made available for that purpose.

No General Taxation for This City.—Ponca City, Okla., a municipality of 20,000 population, is stated to have the distinction of enjoying absolute freedom from general taxation. The city owns and operates its water and lighting utilities and the profits therefrom pay the entire running expenses of its municipal government.

Providing Sewer Facilities in Rural Communities

Formation of County Sanitation Districts in Kansas

By E. F. KINDSVATER
Engineer Douglas County Sewer District No. 1, Lawrence, Kan.

CHAPTER 165 of the Session Laws of Kansas for 1927, authorizes "the construction and maintenance of storm and sanitary sewers in counties having a population over twenty-one thousand and less than seventy thousand, provides for the condemnation of necessary land therefore, and provides for the payment of the cost of such sewers." This law represents the first attempt to provide sewer facilities in unincorporated suburban and rural communities.

The Why of Sanitation Districts.—The enactment of this law and the use that will undoubtedly be made of it comes as a result of the tendency in recent years of urban residents to move out into the open spaces surrounding the cities proper when building their homes. It is not only possible for unincorporated areas surrounding the larger cities to take advantage of the law, but also makes it possible for suburban villages to utilize this method in financing sewer improvements which their taxing limitations would otherwise prevent. It further provides a means for forming a district made up of urban and suburban areas, or of several suburban areas for which a system of sewers and sewage disposal could be designed which would treat the entire area as a whole, each local system becoming an integral part. The law may also prove to be of especial service to summer resort communities and tourist camps from which typhoid frequently emanates as the result of bad sanitary conditions. These resorts can now be cleaned up and given modern conveniences by the help of this law.

Douglas County Sewer District No. 1.—A residential area, located immediately west of the University of Kansas campus and not incorporated with the city of Lawrence, found it necessary to provide sanitary sewer facilities to take the place of an old and very much overloaded septic tank system. Douglas County Sewer District No. 1 was, therefore, formed in April, 1928, when the owners representing "fifty-one per cent or more of the acreage in the district" petitioned the board of county commissioners for its formation.

The board of county commissioners, after duly advertising the petition and making it possible for those not signing the petition to file their protests, employed the writer as engineer to prepare plans and specifications, and superintend the construction of a sewer system. Surveys were made, plans and specifications prepared and with application for the creation of Douglas County Sewer District No. 1, submitted to the State Board of Health for approval.

The policy adopted by the board of county commissioners was to make plans and specifications to cover the entire district and to construct only that part which was necessary to relieve the congested septic tank and provide for the immediate real estate development within the district. In compliance with this policy the commissioners advertised for bids and let the contract for about one-fifth of the complete system. Since then owners within the district have asked that the contract be extended until now the entire system is either under construction or under contract.

Rather than provide a sewage disposal plant for this area, it was found advisable to enter into contract with the city of Lawrence, making it possible to connect the trunk line for the district to one of the trunk lines of the Lawrence sewer system.

Contract Between City and District.—The contract between the city of Lawrence and the district provides: for the payment of $50 for each residence connected to the sewer system; for the payment of a portion of the expense necessary to build or rebuild main sewers in the city of Lawrence, which main sewers under present law, are paid for by the city at large; and for the payment to the city of Lawrence annually a sum equal to the amount which would be raised on all real estate in Douglas County Sewer District No. 1 by a tax equal to the levy made in such year by the city of Lawrence on real estate within the city for maintenance of the sewers of the city.

The contract further provided: that nothing shall be allowed to enter the sewer except such matters as are proper under present ordinances of the city of Lawrence, and any amendments which may be made thereto; that plumbing of any residence within the district shall be installed in conformity with the ordinances of the city of Lawrence relating to plumbing; that all plumbing shall be subject to inspection by the authorities of the city of Lawrence; and that the city of Lawrence may disconnect any residence which may be connected in any way in violation of the contract.

Provisions of Enabling Act.—Provision has been made for the creation of sanitary districts not only by petition from the people within the district, but the board of county commissioners, by resolution, may declare it necessary to build, rebuild or construct, or reconstruct any storm or sanitary sewer, disposal plant, pumping station, or other appurtenances necessary for the proper handling of storm or sanitary sewage, and for which a special tax may be levied. The resolution shall be duly published and if the owners of more than one-half of the property liable for taxation for making such improvements do not within twenty days from the last publication, file protest, the board of county commissioners shall have power to cause such improvements to be made.

The board of county commissioners may create a sanitary district within, or extend any district into, the limits of an incorporated city only upon obtaining the consent of the governing body of such city.

The law further provides, that with the consent of the board of county commissioners, private sewers may be built at the expense of the property owners interested in such improvement, and the board of county commissioners shall have the power to purchase and thereafter maintain sewers so privately built.

Costs Assessed Against Lots.—All costs and expenses involved in creating the district and subsequent construction are assessed against lots and pieces of ground contained within the district in which it is situated (exclusive of improvements), and are levied and placed on the tax roll for collection and collected in the same manner as other taxes. The county commissioners, in its discretion, may provide for payment of the costs thereof by installments, or they may provide for the payment of the entire tax or special assessment at one time.

The board of county commissioners have power to levy a special maintenance tax of not to exceed one dollar on each one hundred dollars of the assessed valuation of the land (exclusive of improvements) within the sewer district or joint sewer districts. The purpose of such fund is solely for creating a maintenance fund to be used for maintaining storm or sanitary sewers, disposal plants, pumping stations, pumps, or other apparatus used in con-

nection with any sewer district or joint sewer district.

The Douglas County Sewer District No. 1 represents the first and only attempt, thus far, to make use of this law in the state; it is, however, not the first attempt in the United States to meet similar problems.

Examples of Sanitation Districts.—The work of the Los Angeles County (California) Sanitation Districts furnishes a notable example of what may be done in solving sewerage and sewage disposal problems by the creation of sanitary districts. In 1926 there were nine County Sanitary Districts in Los Angeles County, covering approximately 432 square miles and including 35 incorporated cities, 35 unincorporated communities, and a comparatively large rural area. The nine county sanitary districts are combined to form the Metropolitan Sewerage System of Los Angeles County, which system has made it possible to treat the entire area involved as a unit in solving the sewerage and sewage disposal problems and treating each district as an integral part. The formation of sanitary districts has been especially desirable in Los Angeles County, not only to cope with the continued and rapid growth in population, but also as a means of conserving the water supply for the entire area.

Another notable example may be cited in the formation of the Sanitary District of Chicago (Illinois). The district includes some sixty municipalities, covering not only Chicago and the Edison Company Territory, but the Public Service Company of Northern Illinois, in part. Some enthusiasts feel that within twenty or thirty years the Sanitary District of Chicago will include all of Cook County. The problem there is primarily one of taking the sewage from the water supply of Chicago and surrounding area, diluting the sewage, then supplementing the dilution by treatment before turning it into the Illinois River.

State laws throughout the United States, with few exceptions, make it possible to form sanitary districts for the collection, treatment and disposal of sewage. It is evident that the development of metropolitan sewer systems must be apart from political boundaries and there must be the fullest cooperation between large cities, small cities, and the developing rural communities. The organization of metropolitan sewer districts is based on the logical grouping of such areas according to their topographic features and common interests. The practice of many municipal authorities at present in solving the immediate demands without thought of the future, will eventually lead to a very ill-advised and uneconomic sanitary scheme, to say nothing of the possible menaces to public health.

Determining Proper Boundaries of District.—A difficult problem presents itself in the determination of the proper boundaries of the sewer district. Provision must be made in correctly designing the sewer facilities for the probable future development of the community. The natural growth of the community will cover land which now may be used only for agricultural purposes, although valued at speculative prices. Such territory, if not included in the sewer district, will obviously be in line for development later and can be sewered only at great expense. On the other hand, to assess an entire township for the construction of sewer facilities which benefit only a very small portion, is clearly unjust. The engineer in establishing the benefit district boundaries must be firm in including such land which is adjacent to and in line for subdivision development and is, therefore, quite obviously benefited by the improvement regardless of the protests from those who may be thinking only in terms of the added return in sale of crops.

From the standpoint of the municipality it is contended by some that the installation of sewers in county sewer districts adjacent to a municipal corporation operates to the disadvantage of the municipality due to the fact that the district provided with sewer facilities and other utilities is not particularly desirous of being annexed to the municipality. This may be true to some extent but, generally speaking, the advantages to a community to be derived by annexation over-balance any possible disadvantages. When a district does comes into the city it represents an asset to it in the way of complete and well designed and constructed sewer systems. Certainly a municipality is fortunate in having the extensions of its sewerage system into the adjacent territory made under capable engineering supervision.

The law providing for the creation of sanitary districts contains the basic elements of a most needed and useful instrument. The refining effects of protests, court actions, experience of use, and legislative amendments, are needed now to make it applicable to all cases that may arise. The legislative amendments that seem apparent at this time would be: first, make provision whereby it would be possible to construct water supply systems in addition to storm and sanitary sewers; and second, since only 22 counties come within the limits set forth in the law, 3 counties exceeding 70,000 and 80 counties falling below 21,000 population (based on 1927 statistics), it would seem that a readjustment should be made in the population limits, possibly the limits eliminated. The act meets a real public need in connection with solving the sanitary problems for unincorporated suburban areas surrounding the larger centers of population, insuring the same regulation by the State Board of Health as applies to incorporated areas.

Acknowledgment.—The foregoing is a paper presented at the meeting of the Kansas Water Works Association.

City Responsible for Damage from Discharging Raw Sewage Into Open Stream

Cities which discharge raw sewage into an open stream and thereby damage farm lands below affected by the polluted waters are responsible to owners of the lands, according to a recent decision of the Indiana Appellate (Supreme) Court, rendered on an appeal of the city of Frankfort against an award in the lower courts to Jay D. Slipher, who brought the original suit for damages. Judgment against the city, in the amount of $3,962.07, was affirmed. Ohio Health News of Feb. 1 comments on the decision as follows:

The decision was a complete affirmation of plaintiff's contention that the city could have remedied the situation, and prevented the damage to his property, by installation of adequate modern sewage treatment works, and that the city, under the law, was responsible for damages caused by its failure in this regard. Sections of the decision of particular interest are as follows:

The contention that appellee could have obtained relief under Sec. 8125 et seq. cannot prevail. These sections simply provide a method by which the common council, the board of health of any city or town, the board of commissioners of any county, the trustee of any township, or 10 per cent of the electors of any city, town or village may file a complaint with the state board of health charging the pollution of the source of any public water supply, or that the water of any stream, spring, lake or pond is being polluted, thereby materially injuring, for domestic use, the character of the water into which the same is discharged to the injury of the public health or comfort. As shown by the title of the act of which the above sections are a part, the statute gives the state board authority to enforce the provisions of the act for the protection of the public health. The statute is not available to an individual landowner like the appellee, who suffers a special injury different from that suffered by the public. The individual landowner must seek relief through the courts, as did the appellee in the instant case.

The first and second contentions of appellant will be considered together.

Appellant argues that since it is by statute authorized to build and maintain an adequate system of sewers for the disposal of its sewage, it may lawfully discharge its sewage without purification into a stream which is the natural outlet, and that so long as such discharge is without negligence it is not liable to a person through whose land the stream flows, though the water of such stream is polluted and the rental value of such land is diminished thereby.

The court, after referring to a number of Supreme and Appellate court decisions bearing upon the issue, said:

The rule of necessity thus declared must in and of itself inevitably force just the opposite doctrine, in the interest of the public health, the very thing supposed to be subserved by the rule, when it is daily becoming more and more apparent that the sewage in the streams is a real menace to the public health, and it is not a necessity, because it can be otherwise provided for, with practicability and assured safety to the public health.

* * * Under the facts as found by the court, public necessity did not call for or require the pollution of the water of either Prairie Creek or South Fork, and since appellant, by the expenditure of a reasonable sum of money, could have adopted a method of purifying the sewage, the judgment should be affirmed.

Operating Experiences With Large Capacity Filter Plant

Data on Purification Works of Essex Borders Utilities Commission

By J. CLARK KEITH

Chief Engineer, Essex Border Utilities Commission, Windsor, Ont.

THE operation of any filtration plant, large or small, usually gives rise to problems which are peculiar to that plant alone. Plant operation may be largely a matter of routine procedure, but there must be constant vigilance to detect the unusual condition when it does appear.

The purification plant operated by the Essex Border Utilities Commission has a nominal capacity of 21 million Imperial gallons per day. In one respect at least it is unusual, in that it is jointly owned by nine communities serving approximately 120,000 people. The capital costs were originally apportioned on the estimated consumption of each municipality five years hence. The operating costs are based on the actual amount of water delivered to each municipality. This is determined by meter measurement. The plant delivers water by gravity to two pumping stations, one privately owned by the Walkerville Water Co., which serves four communities, the other the municipal plant of Windsor, which serves the other five.

The Supply.—The source of supply is in the Detroit River and is a typical Great Lakes water. The initial source of possible trouble in any plant is naturally at the intake. Due to the constant movement of ferries between the Canadian and American shores, there is seldom an ice cover over the intake which is located in 40 feet of water about 1½ miles upstream from the ferry crossing. Under favorable conditions frazil ice develops which has adhered to the 8 ft. bell mouth of the intake, causing partial or complete interruption of flow.

In designing the low lift pumping station, the possibility of such trouble was recognized, as it has occurred in other intakes along the Detroit River. The piping from the pumps was so arranged that pressure could be applied to the intake in the belief that the ice which had formed at the mouth could be blown off. Frazil ice has appeared in this intake on three separate occasions in such quantities as to cause almost complete interruption of service. In each instance, immediate relief has been secured by reversing the flow in the intake. Large masses of ice conforming to the contour of the pipe would then come into the suction well. The average time required for the operation is 25 minutes, during which period the reservoir is being drawn upon.

Frazil ice did not appear during the past winter, though conditions, based on previous experience, were favorable for its formation. Continued cold, not common to this district, caused Lake St. Clair and the upper part of the Detroit River to freeze over and to remain covered with ice. This ice cover prevented the formation of frazil ice in that section of the river from which this supply is drawn.

The water entering the suction wells is comparatively free from the larger debris such as tree limbs, submerged logs, leaves and weeds and no great amount of these is removed by the revolving screens. Late in the autumn fairly heavy quantities of weeds find their way into the suction well. These are believed to be set free by the impellers of passing freighters. It is found that a half revolution per 8 hour shift is sufficient to keep them clean.

Application on Coagulants. — The coagulants, fed from dry feed machines, are applied to the water at the entry to the suction wells and are mixed by the turbulent action of the water in the wells, the passage through the low lift pumps and in the "over and under" type mixing chambers at the entrances to the coagulation basins. Sulphate of alumina is the principal coagulant and the dosage is determined by the quantity and quality of the turbidity in the raw waters. The dosages applied generally range from a minimum of 0.6 G. P. G. to a maximum of 3.5 G. P. D., with an average dosage of 0.89 G. P. G.

During the month of April, 1929, turbidities as high as 800 P. P. M. were recorded. The average for the month was 175 P. P. M., which is the highest monthly average noted since the opening of the plant three years ago. To reduce these turbidities to a maximum of 40 P. P. M. in the applied water and to maintain an effluent of less than 1.0 P. P. M. alum dosages from 20 per cent to 80 per cent in excess of the scheduled dosages were applied. During one 24 hour period it was necessary to apply 5 G. P. G. to a raw turbidity of 275 P. P. M. to produce a satisfactory effluent.

These unusual turbidities are believed to arise from the high water now prevailing in Lake St. Clair. Silt and sand have been accumulating on the shores for years and these have been brought into suspension by the change in lake levels. Lake St. Clair is, relatively speaking, so shallow that even a moderate wind disturbs the entire lake body.

Dosage with Iron and Lime.—Ferrous sulphate and hydrated lime were introduced as coagulants in May, 1928, in an effort to increase the length of filter runs during the "algae" period. During the month of June, 1927, it became necessary to backwash filters every 1½ hours as a result of the high plankton content of the raw water. This affected the quality of the effluent and the delivering capacity of the plant to such an extent that a remedy was sought to better plant operation during that period.

Dosages ranging from 2.4 to 2.0 G. P. G. iron and 1.8 to 1.0 G. P. G. lime were fed and satisfactory results were obtained in all cases. The maximum dosage represented a cost 2.75 times that of the scheduled alum dosage while the minimum dosage cost 1.6 times as much. The lime and iron were fed separately from two dry feed machines ordinarily used for lime. We learned by experience that they could not be fed from the same machine as in combination they formed sulphate of iron within the hopper. It was necessary to add small paddle wheels to the machine delivering lime to prevent arching over. Sulphate of alumina cost $26.20, hydrated lime $14.00 and sulphate of iron $21.00 per ton, all delivered at the plant.

Conclusions Regarding Use of Lime and Iron.—During the period when lime and iron were employed as coagulants, the following conclusions were reached or results attained:

(a) The service hours of the filters were extended to a minimum of 10 hours.

(b) The effluent did not suffer, physically, at all times having less than 0.5 parts of turbidity.

(c) The filter mat showed less signs of shrinkage and cracking than was observed during the "algae" period of 1927.

(d) Lime and iron required approximately 15 per cent more wash water per M.G. filtered than was required with alum as the coagulant when length of run and turbidities were equal.

(e) An increase in the turbidity of the raw water above 25 P.P.M. could

be met with a decrease in the quantities of coagulants used.

(f) The results obtained justified the added cost and the use of lime and iron in the "algae" period will be continued.

The period of retention in the coagulation basins ranges from 1½ to 4 hours, depending upon the demand. The basins are cleaned twice yearly, following the spring algae period and again in the late autumn. Normal procedure permits the draining, cleaning and refilling of a single basin in ten hours.

Mudball.—Mudballs appeared shortly after the opening of the plant. On examination it was found that a large portion of them had formed with a cotton seed as the nucleus. This seed had apparently been in the car in which the filter sand was loaded. Others were flat or almond shaped. The former was found to a depth of 20 in. in the sand, while the latter remained on the top of the bed. They were removed by fishing the beds with wire mesh scoops while wash water was applied at a rate just sufficient to expand the sand. Their appearance was not noted again, to any extent, until November, 1928, when, following a period of slimy turbidity, they were found in all beds. Extra backwashing and fishing with the wire mesh scoops kept them under control and they disappeared early in December. These formations have never been larger than a good sized bean and have been in evidence only twice in three years.

The Sand.—Some shrinkage from the side and end walls has been observed. The average width of the crack is ⅜ in. and it reached a depth of 2 to 3 in. During the spring algae periods, this shrinkage increases and a maximum width of ¾ in. with a depth of 6 in. has been observed. A physical examination of the sand in every bed was made in November, 1928. Samples were taken at four depths and the coating on the sand grains was determined from their specific gravity. The curve used in these determinations was developed at the Detroit filtration plant where the S.G. of the dry coating was found to be 2.0. The S.G. of the dry clean sand is 2.65.

A storage capacity of 2.3 m.g. is afforded in the clear well and reservoir. This represents a supply sufficient to meet the demands of these communities for a maximum period of 7 hours and a minimum, assuming a demand at a rate of 20 M.G.D., of 2 hours and 50 minutes. The reservoir is 11 ft. deep and the minimum working level permitted is 9 ft. 6 in. The average depth maintained is 10 ft. 3 in.

Raw turbidities have ranged from a minimum of 5 P.P.M. to a maximum of 800 P.P.M. The maximum monthly average in 1928, was 125 P.P.M. and the average for the year was 30 P.P.M. The filtered water is checked for turbidity at least six times daily, using a Baylis Turbidimeter. A maximum of 1.0 P.P.M. was present for a few days in 1928 in the effluent, while the average recorded was 0.3 P.P.M.

Rate of Flow.—The rate of flow through the filter beds is governed by three factors: the demand being made upon the plant, the filtering efficiency of the beds and the filter maintenance programme. A filter rate is maintained which will bring all beds into service during the peak hours of the day. Rates are not changed daily. The rates employed in 1928, expressed in terms of Millions of Imperial Gallons per acre per day, ranged from a minimum of 99.6 to a maximum of 118.5, with an average throughout the year of 112.07.

Laboratory control is exercised over all operations in the plant. The raw and applied water are examined for turbidity every 2 hours and the alum dosage changed as required.

Laboratory Control.—Samples of raw and filtered water are collected 5 times daily for bacteriological analysis and colony counts are recorded which develop on agar plates at 37°C. in 24 hours. The average raw water developed 39 colonies per 1 cc. and the filtered water 6 colonies per 1 cc., showing a removal of 85 per cent B. Coli—aerogenes isolations are made following "Standard Method" procedure, using Lactose broth fermentation tubes and Eosine Methylene Agar for confirmation. The results are expressed in term of "Most probable number per 100 cc." The maximum B. Coli content of the raw water has occurred in April when 117.4 colonies per 100 cc. were found. A minimum of 4.99 was recorded in June, while the average for 1928 was 50.44. The average number found in the filtered water was 1.59, with a maximum of 2.39 and a minimum of 0.98, with an average removal of 96.8 per cent.

Air and water temperatures are recorded every 2 hours and the wind direction is noted at these times. It is known that the velocity and direction of the wind have a definite bearing on raw water turbidities during the spring, summer and autumn seasons. It is thus possible to anticipate plant conditions some hours in advance.

Early in 1929 daily examinations of the raw water were begun to determine plankton content. It is expected that a relationship between these findings and the service hours of the filters will be ascertained when sufficient records are available for study. This will provide additional means of determining coagulant dosages. In the three months period in which these examinations have been made, no members of the plankton families, not common in the Great Lakes water, have been identified. Microcystis (Cyanophyciae) appear frequently and represent from 20 per cent to 50 per cent of the total daily counts.

Records.—Daily records are kept of every operation carried on in the various departments of the filtration plant. In the low lift pumping station the rate at which the raw water is being pumped to the coagulation basins and the total gallons pumped are recorded each hour. The total gallons of wash water delivered to the filter beds are also recorded. The power used by the various pumping units and the total power consumption of the plant is recorded once daily. The total hours in service of every unit in the pumping station are logged on the daily report form.

In the filter building all meters, loss of head and rate of flow gauges are read and recorded every hour. The depth of water in the filtered water reservoir is recorded hourly. These daily records are summarized each month and they in turn are built into an annual report. A plant diary provides a permanent record of items of ordinary or unusual interest and constitute a permanent plant history. All gauges and indicating or recording devices are kept in working order at all times and the utmost care is taken to ensure knowledge, if not control, of every operation attempted. One employee is constantly engaged on plant maintenance and it is rarely necessary to place any unit out of service except for inspection or maintenance.

The plant is electrically operated with power supplied by the Hydro Electric Power Commission of Ontario. The rates are $1.00 per H.P. per month based on the peak load, 2¼ ct. per K.W. for the first 50 hours 1½ ct. for the second 50 hours and .33 ct. for all additional power.

Operating Cost.—Operating costs, divided into five major divisions, i.e. salaries, power, overhead, coagulants and maintenance, totalled $12.58 per M.G. filtered.

The average cost of coagulants per M.G. was $2.09, which included the added cost of "Lime and Iron" coagulation. During the period when "Lime and Iron" coagulation was employed, the average cost per M.G. was $4.09. Alum coagulation during the balance of the year represented an average charge of $1.71 per M.G. filtered.

Salaries represented $4.28 of this sum, Power $2.74, Overhead $2.33, coagulants $2.09 and maintenance $1.24.

The operating staff includes a superintendent, a chief operating engineer, a chief filter operator, three operating engineers, two filter operators and a utility man. The lowest wage paid is 62½ ct. per hour.

The total power consumption for 1928 was 1,455,000 K.W. Hrs., costing an average of 0.82 ct. per K.W. Hr. The pumping cost for power alone, exclusive of wash water, average $2.55 per M.G. or 6.7 ct. to raise 1 M.G. 1 ft.

Overhead charged include supervision, rentals paid for use of railway right-of-way, taxes and insurance. A depreciation reserve of $3,000 is set aside annually to replace the heating system, motors and pumps which will

need replacement within the 30 year life of the debentures.

Maintenance charges include the general upkeep of machinery, buildings and grounds and the purchase of miscellaneous supplies required in this work. The grounds are attractively maintained as water works plants should be. Acknowledgment is made to G. H. Strickland, plant superintendent, for much of the information contained in this paper.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 49th Annual Convention of the American Water Works Association.

Fibrated Asphalt Planking Waterproofing Floor Construction on LaSalle St. Bridge, Chicago

Of late years a great deal of attention has been directed by engineers to some vital requirements in the construction of floors and of the waterproofing course, on both fixed and movable bridges and on the approaches to such structures.

In the specification of materials entering into the construction of the La Salle St. bridge, Chicago, and the approaches to it, considerable attention was devoted on the part of engineers to the requirements of this particular structure—first, as relating to the waterproofing, and second, relating to the wearing surface on the bridge itself.

The illustration, Fig. 1, is of the north approach to the bridge, and the picture shows a crew installing the fibrated bituminous waterproofing planks of the Servicised Products Corporation, Chicago, directly over the waterproofing fabric itself. On the deck pictured, 14,000 sq. ft. of fibrated asphalt sheets, 24x36 in., were laid as a protection to the waterproofing. The waterproofing fabric was laid over the concrete, and while the asphalt was still in a plastic condition, the waterproofing fibrated asphalt planks were placed in position. The granite block paving for the bridge approach was laid immediately over the waterproofing protection course.

The preformed fibrated bituminous sheets provide a blanket of tough, resilient material over the waterproofing, which reinforces the waterproofing itself by increasing its thickness or body, and so protects it from direct damage. It is claimed that due to the fibrous nature, toughness, high tensile strength and the inherent waterproofing qualities of the protection course, the integrity of the waterproofing is maintained indefinitely, regardless of shock and vibration from traffic, the condition of the weather or the state of the temperature.

Its use prevents leaks through the structure, as the greater the pressure upon it, the tighter the waterproofing becomes. The material is sufficiently strong and tough so that it bears the usual loads without distortion.

The very quality of resiliency and toughness enables it to give and take the movements of the main structure. Such a waterproofing course has also some of the qualities of an expansion joint in that it is unaffected by extremes of temperature.

Figure 2 shows Servicised fibrated asphalt plank being installed on the south leaf of the La Salle St. bridge.

The outstanding feature of fibrated asphalt planking is its adaptability to any particular surfacing requirement. The composition of the material can be varied to meet the practical necessities in each case. Fibrated bridge flooring material is constructed of asphalt saturated felt and asbestos fibre for binding, and of asphalts thoroughly mixed with fine mineral matter for compressive strength, and for increasing the abrasive and wearing qualities.

To increase the tensile strength, mats of irregularly overlapping fibre are introduced and further resiliency is effected by inserting divided fibre between the spaces or mats of the linear fibre.

Fig. 2—Servicised Fibrated Asphalt Planking Being Installed on the South Lift of the La Salle St. Bridge, Chicago

When the material is finally incorporated by pressure, into a block-like structure, it is then a composition of extreme toughness, highly resistent to wear and at the same time, extremely resilient and accommodating itself easily to the expansion and contraction movements of the bridge structure.

It is easily laid, in fact just as easily handled as wood planking. There is no difficulty in using the material any time of the year in any climate and without especially trained labor.

Streets and Sidewalks at Boston, Mass.—Boston has a total of 626 miles of roads. The total area of the streets is 11,919,844 sq. yd. The average width of street is 48 ft., the average width of roadway 32 ft., sidewalks 8 ft., residential streets 40 ft., residential roadways 26 ft., and sidewalks 7 ft. The width of boulevards varies from 100 ft. to 200 ft., with roadway width from 25 ft. to 43 ft. The sidewalk widths range from 12½ ft. to 25 ft. The park strips range from 25 ft. to 100 ft. The width of thoroughfares is from 60 ft. to 122 ft., with a roadway from 40 ft. to 92 ft. Sidewalks range in width from 8 ft. to 20 ft.

Fig. 1—Servicised Waterproofing Slabs Being Installed on the North Approach to the New La Salle St. Link Bridge, Chicago. Approximately 14,000 Sq. Ft. of 24x36 In. Fibrated Bituminous Planks Were Used, and the Granite Block Pavement Laid Immediately on This Cushion

Electrically Welded Pipe Line for Springfield, Massachusetts

Process Employed in Fabricating Proven Mountain Line

By S. MARTIN, JR.
Industrial Engineering Department, General Electric Co., Schenectady, N. Y.

THE pipe for the Springfield water line was made in 30 ft. lengths from two 30 ft. plates which were bent into half circles and automatically arc welded together. Some consideration was given to welding of the girth joints in the field, but because of considerable opposition, it was decided not to do this on this particular job, and the 30 ft. sections were riveted together in the field. To provide for this, the plates were sheared so that the pipe diameter increased slightly from one end to the other, thereby permitting the small end of one section to fit into the large end of the next section an amount required for the riveted joint.

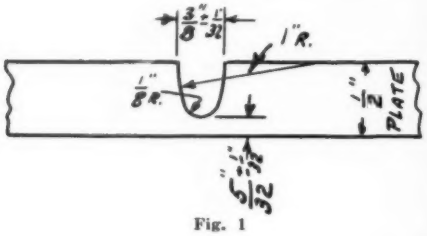


Fig. 1

The first operation in the manufacture of the pipe after the flat plates had been sheared to size was to bevel the sides accurately as shown on Fig. 1. This is done simultaneously on two plates on the plate planer, as shown in Fig. 3. On each plate two lines were then scribed, parallel to the upper edge of the bevel and ¾ in. from it.

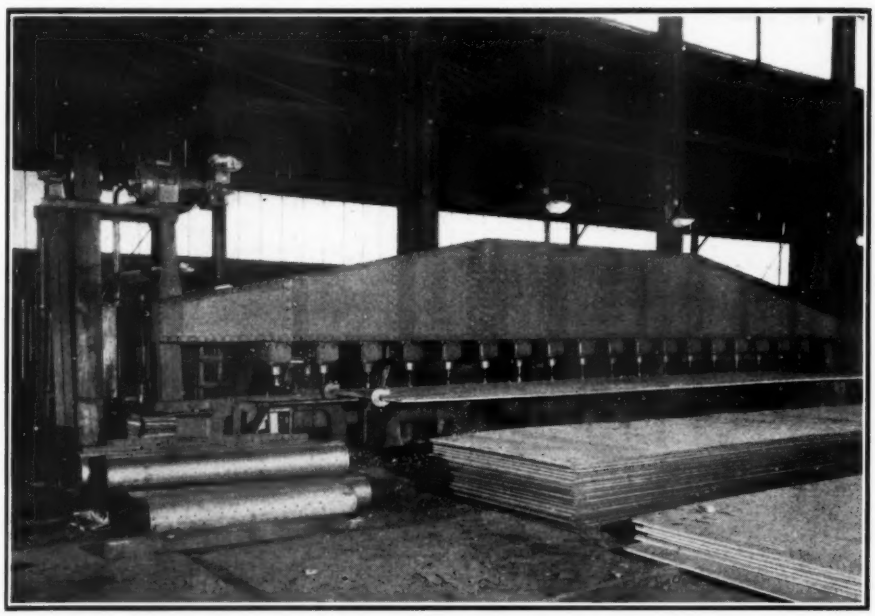


Fig. 3—36-Ft. Planer with Two 30-Ft. Pipe Plates Clamped in Position for Planing U Bevel Preparatory to Rolling and Welding

The plate was then taken to the bending rolls, and by means of a special jig, the 30 ft. edges were bent to the proper radius. The whole section was then formed into a true half circle. Next the two halves of the pipe were placed in a specially designed frame, Fig. 5, and tack welded together approximately every 16 in. on the inside, by hand. The pipe section was then removed and a complete bead run inside by hand. It is then ready to be placed in the welding machine as shown in Fig. 6.

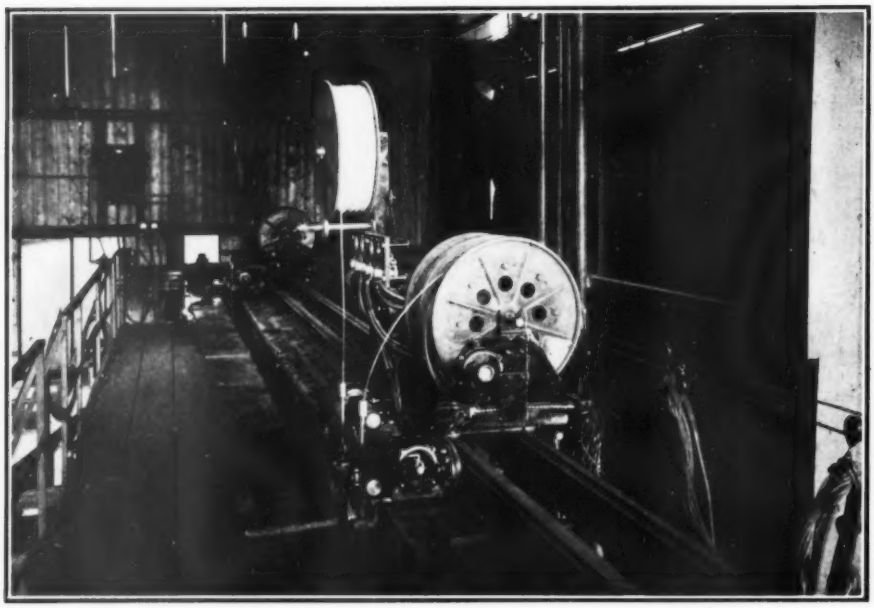


Fig. 2—Two Multiple Arc Welders with Travel Carriages Mounted on 36-Ft. Pipe Welding Machine

Pipe Welding Machine.—The pipe welding machine consisted essentially of three horizontal beams, two above and one below. Enclosed in the lower beam and extending throughout its full length were several sections of fire hose to which compressed air was admitted. On the hose rested a series of plungers, which is turn supported a "backing bar," the latter being fitted with a flat copper chill bar approximately 2 in. wide. Application of compressed air caused the hose to expand, thereby raising the plungers and the copper strip in the backing bar was pushed up against the under side of the joint at a pressure of 200 lb. or more per running inch. The backing bar was also provided with an insulated conductor which formed part of the return circuit for the welding current. By shunting the proper cur-

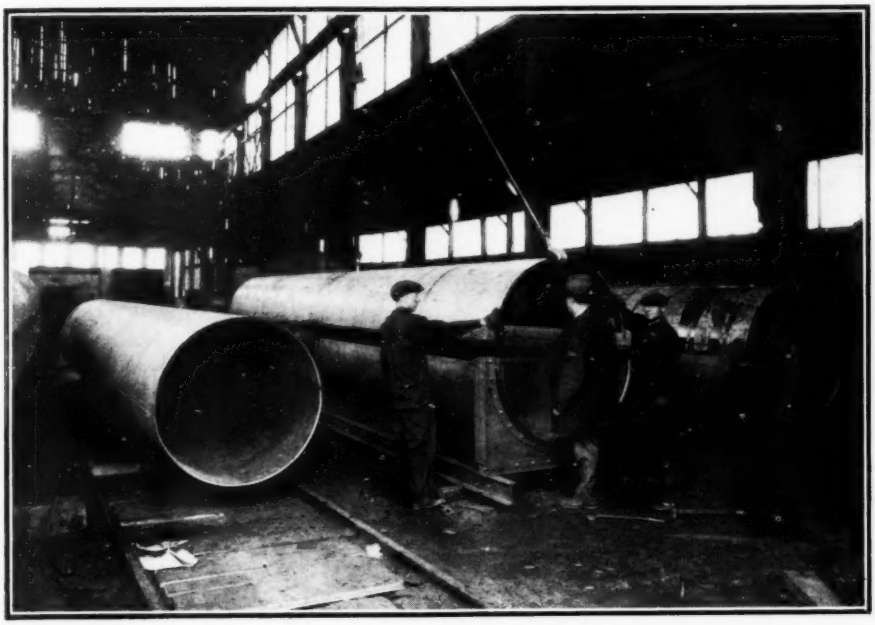


Fig 5—Assembling by Tack Welding Two Halves of a 30-Ft. by 48-In. Diameter Pipe Before Going to Automatic Welder

rent through this bar when the pipe was being welded, the magnetic disturbances of the arc were very effectively controlled.

To the lower side of the upper beams of the machine were attached two copper jaws spaced approximately 2 in. apart and the pipe was placed in the machine so that the joint to be welded was located centrally between these two copper jaws and directly over the copper strip in the backing bar.

Figure 2 shows the double head automatic travel carriage for the welding after the plates have been properly clamped in the welding machine. Two such carriages were mounted on the 30-ft. machine. This meant that each one of these did 15 ft. of pipe and reduced the welding time to 50 per cent of that required for one carriage. A third such double head travel carriage is being contemplated for a further saving of welding time on future operations.

After one seam was welded, the pneumatic clamp was released and the pipe rotated to bring the second joint in position.

Speed of Welding—Electrode-Power Consumption.—The speed of welding attained by the multiple arc process with two welding heads on ½-in. plate was approximately 28 ft. per hour. Using the welding conditions formerly outlined, about 1 lb. of electrode was deposited. The current for each pair of welding heads was supplied from a 1,000 ampere-1 hour rated constant potential welding generator driven by an induction motor. The power consumed was approximately 2.15 kw.-hr. per foot of weld on ½-in. thick plate.

Testing.—At the request of the inspector, check test plates about 12 in. long and a total width of 16 in., with a bevel as specified for the pipe joints, were placed at each end of the pipe seam and welded under the same conditions as the pipe itself. These plates were then cut into specimens. Some of these were tested in tension, others bent and still others were put in a fatigue testing machine.

The pipe itself was given a thorough visual inspection to determine possibility of holes, lack of fusion and reinforcement. The weld was reinforced—i. e., its height above the surface of the plate was usually from 1/16 to ⅛ in. The minimum and maximum values permitted by good practice are 1/32 and 3/16 in. respectively. The weld bead must also be central between the scribed lines on the plate at each end of the joint, allowing a maximum variation of 1/16 in. from the center. The width of the weld bead was measured and its over-all width was not permitted to be less than 9/16 in. Any holes which were seen on the top surface of the deposited metal were carefully chipped and if they extended below the surface of the plate, the spot was rewelded by hand. The edges of the bead were also examined to see that the weld metal was thoroughly fused along the top of the plate. Any cracks or hollow spots were chipped and rewelded by hand.

After the welded pipe had been given a careful visual inspection and any defects rewelded, it was placed in the testing machine, Fig. 7, and subjected to the following hydro-static pressures in pounds per square inch:

Thickness of Pipe in In.	5/16	⅜	7/16	½
66-in. pipe	....	160	....	....
54-in. pipe	135	160	187	213
48-in. pipe	....	....	210	240
36-in. pipe	....	....	....	320

In this particular installation the rivet holes were then punched in each end of the pipe, after which it was thoroughly cleaned and dipped vertically in an electrically heated tank of coal tar pitch varnish (Fig. 8). The pipe was submerged in the bath long

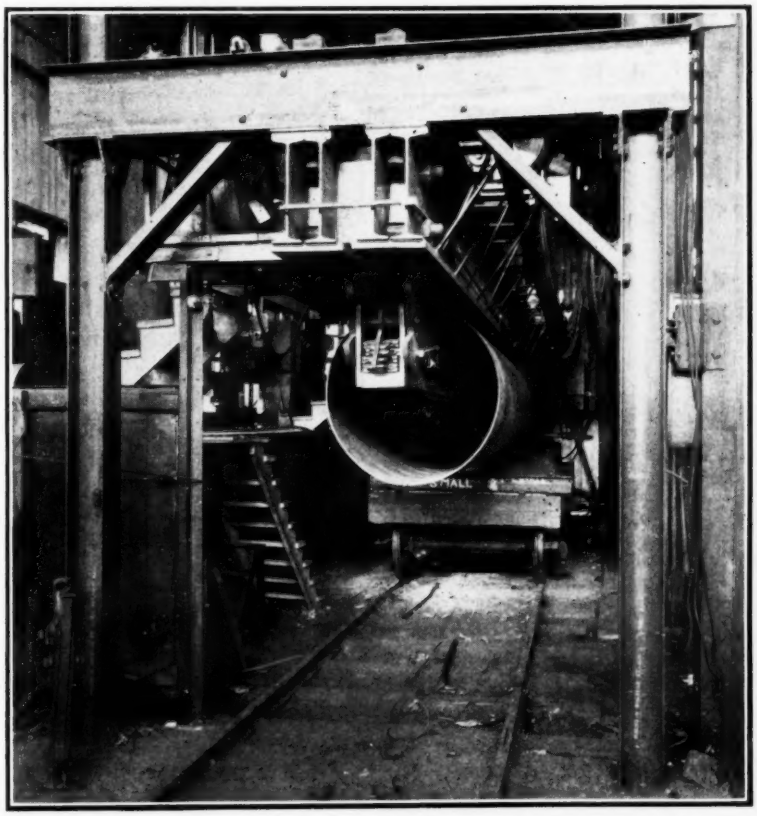


Fig. 6—Loading End of 36-Ft. Pipe Welding Machine Shows Lower Supporting and Pneumatically Operated Backing Up Beam Locked in Position for Welding

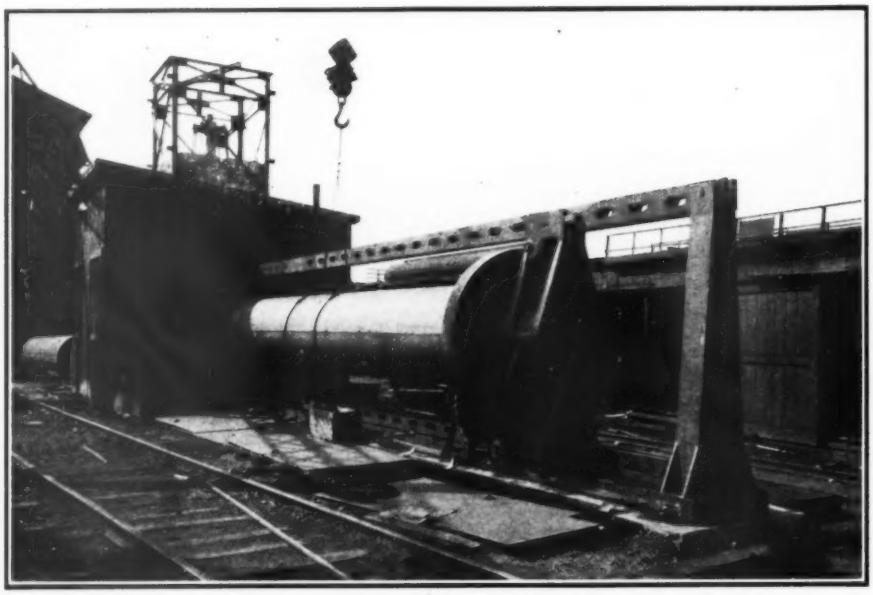


Fig. 7—Hydraulic Testing Machine with 30-Ft. Long, 48-In. Diameter Pipe in Place

enough to heat the metal uniformly to the temperature of the bath. It was then removed and suspended in a vertical position until the coating had drained and set.

Acknowledgment.—The above is abstracted from a paper presented at the 49th annual convention of the American Water Works Association.

Water Rates

In the sale of any commodity, and water is a commodity, there must be in all fairness some basic principle upon which its cost of production and sale can be established, so that each individual may receive equitable results. In other words, the cost of service is made the legal basis for rates. To determine upon a rate which is fair and equitable, both to the consumer and to the water department, demands a consideration of all the factors which enter into the operation of the plant. These may be designated and grouped to meet requirements of the individual plant and existing conditions. The practice of determining rates by comparison with other cities is a false standard.

Water rates should be based upon the cost of production. A very important element is the value of the property that is rendering service. In order to render good service, the utility must be financially sound. It has been my observation that financially poor utilities and poor service go hand in hand. The rate charged must be sufficient to meet all fixed charges, otherwise the utility cannot function on a sound financial basis. Our rates are just, fair and reasonable, and are based upon the cost of the finished product, without regard in any way whatever to the rates in vogue in any other city, whether higher or lower.—Extract from 1928 annual report of W. H. Lawrence, Superintendent of Water Works, Kalispel, Mont.

Fig. 8—Lowering a 30-Ft. by 48-In. Automatically Arc Welded Pipe Into an Electrically Heated Vertical Tank of Coal Tar Pitch Varnish to Give Pipe a Protective Coating

Municipal Garbage Removal Governmental Function

The Supreme Court of Appeals of Virginia, in a decision rendered March 21, 1929, in the case of Asbury v. City of Norfolk (147 S. E. 223), held that garbage removal by the city was a governmental function. The decision is reported as follows in Public Health Reports May 31, 1929:

An action was brought against the city of Norfolk because of personal injury to plaintiff caused by being struck by a runaway horse which had been hitched to a wagon being used at the time in the removal of garbage. The question which was before the Supreme Court of Appeals was whether, in the removal of garbage, the city was acting in a governmental capacity and was thus relieved from liability for negligence. The holding was that garbage removal by a city was a public governmental function, as contrasted with a corporate or private function, and that the city was not liable. In deciding the matter the court said that "There is some conflict in the cases, but the weight of authority quite certainly is to the effect that the removal of garbage by a municipality is a governmental function, which is designed primarily to promote public health and comfort, and hence that the municipality is not liable therefore in tort when the negligence which is charged occurred in the performance of that particular function, and no nuisance is thereby created."

Financing the Operation and Maintenance of Sewage Treatment Plants

How This Important Problem Is Handled in Various States

By EARNEST BOYCE
Chief Engineer, Kansas State Board of Health, Lawrence, Kan.

THOSE interested in the problem of adequate sewage disposal are constantly confronted with the fact that sewage disposal plants built to accomplish the destruction of the objectionable characteristics of sewage wastes are, after being built, frequently not operated so as to obtain the results expected. While many plants are given good supervision, in at least the average plant the operation must be considered as being the minimum attention that the city can give and yet avoid damage claims due to faulty operation. Governing bodies are usually willing to provide adequate funds for city departments when the expenditure is demanded and expected by the taxpayer of the city, but it is hard with the many demands made on a city's financial resources for a governing body to provide funds to dispose of sewage wastes after they are conveyed to a point where they will not annoy the residents of the city.

The demand for the installation of sewage treatment works and later for their efficient operation comes in most cases not so much from a sense of civic responsibility as from demands by damaged property owners with threatened suits or from some state supervisory authority—usually the State Department of Health. Consequently, a city is quite apt to adopt, or rather lapse into a policy of doing only that which is definitely required. A sewage disposal plan may be considered as manufacturing a product of little or no value out of a waste material which, before this process existed, was a definite liability. No revenues are produced that in any way equal the expense, consequently the cost of the plant and its operation must be paid out of benefits that accrue from the removal of the liability represented by the untreated sewage waste.

The most common place to carry the cost of sewage treatment is to include it in the general tax levy. There is some reason to consider this as a just and proper place for the charge. But funds must be available and the proper appropriations secured in competition with many other demands.

Sewer Service Charge.—If we consider that a system of sewerage exists only to give service to those contributing sewage wastes, then we should properly classify this municipal improvement with other public utilities and expect that all charges for capital and operating costs be paid by those who are served. This view has been reflected in recent legislation in several states where provision is made by statute for the charging of sewer rentals. There are some who feel that a sewer is not properly a public utility but rather a necessity from the standpoint of public health and being necessary to the health and well-being of the community should be paid for by the community as a whole. When an individual makes use of a public utility, such as telephone, electricity, gas, or water, he is primarily interested in the service given by such a utility. A person not interested in having this service is at liberty to do without it. While it may inconvenience others, his unwillingness to have the utility does not create any hazard for his neighbors. With the sewer, it is different. It is important that all and not a part of the sewage wastes be removed from the city. The poorest as well as the most expensive property should be given service,—in fact, not infrequently it is necessary to require in the interest of better sanitation that sewer connections be made against the property owner's will. Such procedure would be unheard of with any other utility. It is more nearly comparable with fire protection service. This comparison might be carried further. We divide our public water supply costs and charge fire protection costs to general taxation and the costs of water supply service to the consumer, in proportion to the use he makes of this utility. It would seem that the principle that has been followed in the past of paying for sewers and sewage disposal improvements by general tax levy is a sound one, but it may be that after the community has, as a whole, provided this service, it is proper that those who use the sewers should pay for their maintenance and operation, and possibly in approximate proportion to the amount of such use.

The cost of sewage treatment was formerly principally one of first cost with a very small item, proportionally, of maintenance. At present, where modern sewage disposal is provided or where all or a part of the sewage must be pumped, there is an annual charge that must in some way be carried in the budget of the city. The service has undoubtedly gone beyond where all the expense should be considered as incurred in the interest of sanitation alone.

If charges are made against the use of the service rendered by a system of sewerage, there remains the problem of deciding how these charges should be apportioned. It has been suggested that since sewers primarily serve the purpose of removing the city water after it has been used, the amount of water used is a measure of the use made of the sewer and might give a rational basis for rental or service charges.

How the Ohio Rental Law Works.—The subject of sewer service charges as a means of financing sewerage and sewage treatment was given consideration by a committee on sewage treatment at the Conference of State Sanitary Engineers. It was considered as one of the three main items to be considered in 1928 by the committee, the other two being, first, a study of progress in establishing technical operation of treatment works and, second, continued sewage treatment research. The operation of the Ohio sewer rental law enacted in 1923 was discussed in detail in their report as follows:

"It is well to review briefly the sewer rental situation in Ohio. Seventeen municipalities are now financing their sewerage and sewage treatment works either in whole or in part out of moneys collected from sewer rentals. The smallest municipality in this list has a population of less than 600 and the largest over 150,000. The charges average about $4 per sewer connection per year, although they vary from $1 to $8 annually. Payment is usually made upon the quarterly plan. The manner in which the charges are made vary. The number of municipalities basing the charges upon the volume of water consumed (5) about equals the number making a flat rate single charge per sewer connection (4). A flat rate according to the number of fixtures is employed by two; and two others have a flat rate schedule per connection according to the character of the premises served. Variations in amounts of charges are on account of the variations in size of the municipalities, and the differences in amounts of funds attempting to be secured. For example, the $4 annual charge at Delaware (8,576) is planned to meet expenses of maintenance, operation, etc., but not to meet sinking fund charges on the new plant. In order to include a substan-

tial portion of the sinking fund or replacement charges, the small city of Kenmore (12,683) charges $8.

"There seems to be a well defined trend in Ohio and elsewhere to adopt the rental or utility idea of financing sewerage works maintenance and operation. Experience indicates that such a plan is most favorably considered and is easy to place in operation wherever a new sewage treatment works is being installed or a complete renovation being given to an old treatment plant."

From other references, we find that the estimated revenue from sewer rentals at Delaware, O., will amount to $11,000 per year. It is estimated that this will be sufficient to maintain and operate the treatment works, and the sewerage system as well. It will also carry the clerical cost necessary for collection. Sewage pumping is necessary and the sewage is treated by passing it through an Imhoff tank and sprinkling filters.

The North Carolina Law.—The Sessions Laws of North Carolina for 1927 provide for the creation and maintenance of sanitary districts. Section 20 of that law is interesting in that it covers service charges and rates in the following words:

"A sanitary district board shall immediately upon the placing into service of any of its works apply service charges and rates which shall, as nearly as practicable, be based upon the exact benefits derived. Such service charges and rates shall be sufficient to provide funds for the proper maintenance, adequate depreciation, and operation of the work of the district. Any surplus from operating revenues shall be set aside as a separate fund to be applied to the payment of interest on bonds, to the retirement of bonds, or both. As the necessity arises the sanitary district board may modify and adjust such service charges and rates from time to time."

The Michigan Law.—Michigan statutes provide that a city may, by charter, acquire, establish, operate, extend and maintain sewage disposal plants, sewers and plants, either within or without the corporate limits of the city, as a utility, including the fixing and collecting of charges for service covering the cost of such service, the proceeds whereof shall be exclusively used for the purpose of city sewage disposal system to include a return on the fair value of the property devoted to such service, excluding from such valuations such portions of the system as may have been paid for by special assessments.

In act 320, Michigan Statutes 1927, a portion of Section 2 reads as follows:

"Such sewage disposal plant and system shall be considered a public utility within the meaning of any constitutional or statutory provision of this state for the purpose of purchasing, owning, operating, constructing and equipping such sewage disposal plant and system."

Section 2 further provides that a municipality may issue bonds beyond the general limits of the bonded indebtedness providing such bonds shall not impose any general liability upon the municipality but shall be secured by revenues from the operation of the system of sewerage. It likewise provides that the system of sewerage may be taken over and operated under a franchise as a security provision for bonds.

Section 3 provides:

"The legislative body may establish just and equitable rates or charges to be paid to it for the use of such sewage disposal plant and system by each person, firm or corporation whose premises are served thereby."

The Provision in Pennsylvania.—In the 1927 Session Laws of Pennsylvania, Section 2170 to 2173, inclusive, the following provision is made for the assessment of cost of maintenance and repair:

"Whenever any borough has constructed any sewer or sewer system, or has acquired wholly or partially the same at public expense, the council of such borough may provide, by ordinance, for the collection of an annual rental or charge, for the use of such sewer or sewer system, from the owner of property served by it. The council may, at its discretion, in lieu of such annual rental or charge, provide for the payment by such owner of a fixed sum.

"Such annual rental shall not exceed the amount expended annually by the borough in the maintenance, repair, alteration, inspection, depreciation, or other expense, in relation to such sewer or sewer system, and may include any interest on money expended by the borough in the construction of the sewer or sewer system. The said annual or fixed sum shall be apportioned equitably among the several properties served by the said sewers.

"Such annual rental or charge, or such fixed sum, shall be authorized and collected as provided by general ordinances, and, when so levied and charged, shall be a lien on the properties charged. The collection thereof shall be made and enforced in the manner municipal claims are now or may hereafter be collected.

"The councils of such borough shall execute a warrant or warrants, authorizing the collection of such annual sewer rentals or charges, or such fixed sum, to the officer employed by council to collect the same. Such officer shall have the authority now vested by law for the collection of borough taxes.

"Such annual sewer rentals or charges, or such fixed sum, shall be a lien on the properties charged with the payment thereof, from the date set forth in the ordinance, and, if not paid after thirty days' notice, may be collected by an action of assumpsit, in the name of the borough against the owner of the property charged, or by distress of personal property on the premises, or by a lien filed in the nature of a municipal lien."

The Kansas Law.—A statute may provide that special levies may be made for maintenance and operation. For example, the Kansas law in Section 12-630, Revised Statutes of 1923, provides as follows:

"Levies for sewage disposal plants. That all cities of less than 50,000 in the state of Kansas be and are hereby authorized to levy a tax, in addition to all other taxes allowed by law, not exceeding one-half mill on the dollar upon all taxable property in such cities, to be collected as other taxes and used for the purpose of maintaining and operating sewage disposal plants. Such levy shall not prevent the use of other funds available for the same purpose."

We believe that in the future more thought will be given to the matter of providing adequate operating revenues and that some sort of service charge will be more generally adopted as being an equitable method of providing these revenues.

Advantages of Service Charge.—One of the principal advantages that we see in the application of a service charge is that funds can be provided continuously without the necessity of an annual appropriation. A source of revenue is provided that does not come in direct competition with other budget items that must be included in the tax levy. This is important because the public, as we suggested in the beginning of this paper, are not usually as much interested in matters pertaining to sewage disposal as they are in other budget items and when an economy cut is made in the tax levy or funds are needed elsewhere, sewage disposal operating funds are either forgotten or so reduced as to make efficient operation impossible.

This subject is one to which we should give further thought. It is somewhat removed from the design problem that we usually consider, but fully as important. Design without adequate operation is valueless, and a sewage disposal plant that is operated only when funds happen to be available cannot be depended upon to accomplish the purpose for which it was built.

Acknowledgment.—The above paper was presented at the 9th Iowa Sewage Treatment Conference, held at Ames, Ia.

Sidewalk Zoning.—A new plan for zoning sidewalks has been put into effect by the city of Detroit, Mich. Sidewalks on the chief shopping avenue are marked off into three lanes—one for northbound pedestrians, one for southbound, and an inside lane where window-shoppers can loiter as much as they like. At street intersections painted foot-prints direct people into the right lane of traffic. The plan was first installed for the Christmas shopping season, and met with such success that it is to be adopted permanently.

Zeolite Softening Plant Operating Experiences

Data on Plants of Ohio Valley Water Co. and Sewickley, Pa.

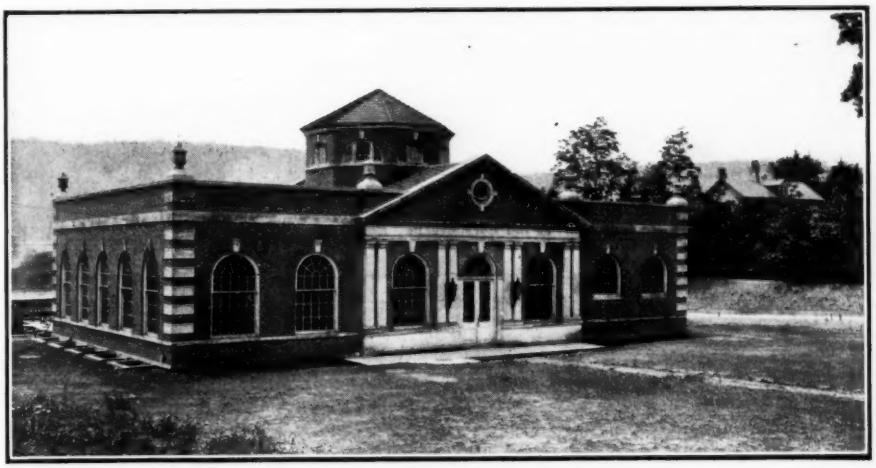
By D. E. DAVIS and J. T. CAMPBELL
Of the J. N. Chester Engineers, Pittsburgh, Pa.

THE data and comparisons herewith have to do with the 4,000,000 gal. pressure type softeners at the plant of the Ohio Valley Water Co. about six miles below Pittsburgh, Pa., and the 2,000,000 gal. open-softener type plant for the Borough of Sewickley, Pa.

Salient Features of Plants.—The salient features and contrasts are briefly summarized in Table I:

The distinguishing differences between the two plants reside in the contrasts between pressure and open type units. The open softeners at Sewickley, being designed for use as filters as well as softeners, operate at usual filtration rates and correspond closely to rapid sand filtration practice as regards head losses, sand rise, etc. The pressure type softeners at the Ohio Valley Water Co. operate at about twice the rate of the open filters, but require materially greater head in the ratio of 32 ft. to 5 ft. The open units permit of ready and continuous observation of the process, which is difficult of accomplishment in the closed units, because of the design.

A wash rate up to 13 gal. per sq. ft. per min. is possible without loss of sand on the open units, although (with the clear water handled) the rate of 7 gal. is found satisfactory. The closed type units have shown considerable losses at the recommended 6 gal. rating, and have given some trouble at four. This is probably due to the fact that their circular cross-section, and cost considerations on the shell limits



View of 2,000,000 Gal. Water Softening Plant of Sewickley, Pa.

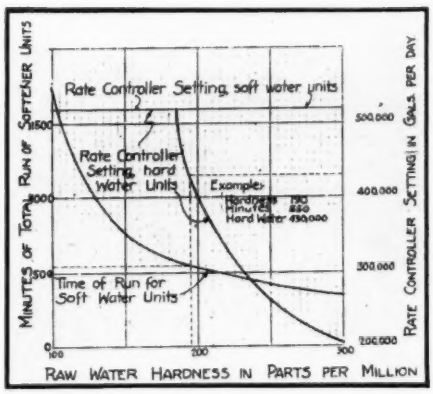

Rate Controller Setting, soft water units
Rate Controller Setting, hard water units
Example:
Time of Run for Soft Water Units
MINUTES OF TOTAL RUN OF SOFTENER UNITS
RATE CONTROLLER SETTING IN GALS. PER DAY
RAW WATER HARDNESS IN PARTS PER MILLION

Fig. 2—Curves for Control of Operations

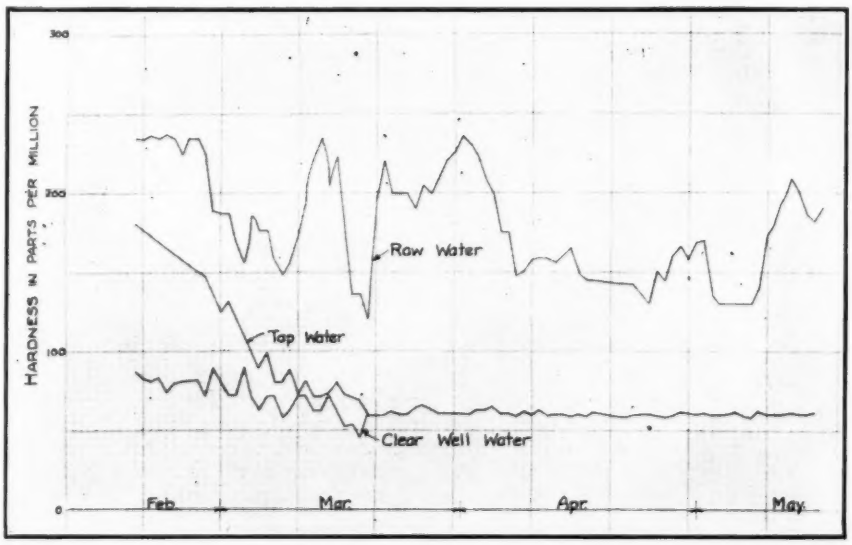


Fig. 1—Operating Results in Terms of Hardness

the distance above the sand line at which the off-take pipe (corresponding to wash trough) can be placed. As the wash water rises it is compelled to converge toward the center at the upper segment of the circular cross-section, thus relatively increasing the velocities. This fact together with the short distance between sand and off-take limits the wash rate and evidently makes it difficult to prevent some loss of sand. Experience thus far with the open units indicates that this difficulty has been obviated in that design, since no losses can be detected.

The sand cross-section in the open unit is rectangular, which is not quite true of the circular closed unit. Standard rate controllers are used on the open unit, whereas the closed unit passes the quantities which the available head loss imposes. In these two features, the open filter appears to advantage, in that the water (and brine solution) seems to travel with greater uniformity downward through the sand thus assuring the fullest regeneration of each sand particle and the maximum removal of hardness per cu. ft. of sand.

Operating Results at Sewickley.—The graph in Fig. 1 presents operating results since the Sewickley plant was started. The hardness of the water reaching the consumers was reduced gradually down to 60 p.p.m. at which figure it has been maintained. This was accomplished by gradually softening the several days' reserve in the borough reservoirs. There was evidently no difference in the taste between the hard and soft water—at least no general comment has been voiced. Some complaints were expected, either for imaginary or real reasons; and ac-

cordingly precautions were taken for making daily bacteriological and chemical analyses on samples taken in the process steps from the crib through to the reservoir. So far as known, not a single complaint was made.

The plant has proved to be quite simple and fool-proof in operation. The zeolite filters are set at a constant rate of about 2 gal. per sq. ft. per min. while the hard water filter is set at the approximate rate shown in the curve of Fig. 2. The second curve indicates the period of run, and by following the procedure there set out, the final product is kept close to 60 p.p.m as may be seen in Fig. 1.

The individual operation consists in turning the effluent of the newly regenerated softener into the soft water clear well, from which it proceeds to the mixed water clear well, there mingling with the hard water effluent from the hard water clear well. The operator usually checks (by soap method) and records the end of the soft water run, and of the "Twilight Zone" or period during which the zeolite bed completes its exhaustion of sodium, and the hardness changes from zero to that of the raw water. The latter part of the entire run usually involves the delivery of hard water through the bed. The operator finishes the total run by closing the raw water valve, and pulling the water to within an inch or so of the sand. He then closes the effluent valve, presses the button to start the brine pump which delivers the brine solution over the bed, and then opens the rewash valve to a calibrated point so as to pull the brine down through the zeolite sand at a rate from 1.5 to 2.0 gal. per sq. ft. per min. After the brine solution approaches the sand line, the

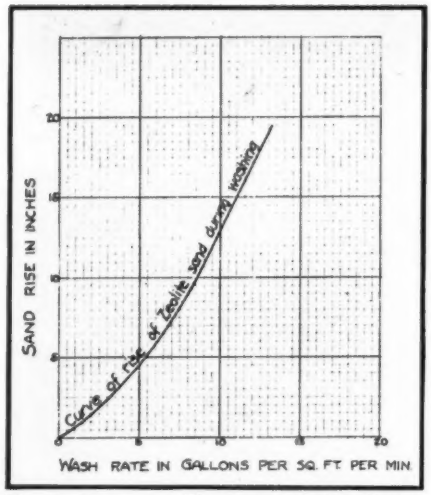


Fig. 3—Curves for "Green Sand" Rise During Back-Washing Operation. Sand: Effective Size .285 mm.; Uniformly Coeff. 1.50

rewash valve is fully opened (to about a 3.2 gal. per sq. ft. per min. rate), and also the influent valve.

During this period of "rinsing" the waste chlorides are washed out to waste through the sewer. After a total elapsed period of approximately 35 minutes, the rinsing is pronounced complete, as determined by tests explained in Fig. 4, and the softener is started on another cycle.

Units have been back-washed on an average of once in 71 hours of service during which period the head on the softener units increases from 4.8 at the start to 7.2 at the end, contrasted to 2.9 and 6.4 for the hard water unit.

The record of 15 consecutive runs is shown in Table II:

During an earlier experimentation period the results for 38 observations indicated a removal of 3,790 grains of hardness per cu. ft. of green sand, and the salt dose .353 lb. per 1,000 grains removal.

This improvement has been effected by changing the dilution of the salt dose, while maintaining the same quantity of salt in all cases. In the earlier runs an 8.6 per cent solution (by weight) was employed, whereas the latter regenerations have been made with a 5 per cent solution. The apparent explanation of the result is that the more dilute solution permits the salt to bathe each sand grain for a longer period than is true of the concentrated solution, and induces a more complete exchange of sodium.

Table I

Plant	Ohio Valley Water Co.	Borough of Sewickley, Pa.
Type	Pressure	Open
Number of Units	4	4
Nominal Cap. in Gals. per 24 hours	4,000,000	2,000,000
Area per sand bed in sq. ft.	208	181.5
Cubic Feet of Sand per Unit	670	470
Direction of flow	Downward	Downward
Rate of flow in gals. per sq. ft. per min.	4.3	2
Rate of flow control	None	Rate Controllers
Wash Rate in gals. per sq. ft. per min.	4 to 6	6 to 13
Sand Rise during Wash in inches	4.7 to 5.6	5.6 to 18.5
Pounds of salt per 1,000 grains removal	.344	.334
Grains removal per cubic foot	3250	4004
Salt Dose	Variable	Constant
Grain Characteristics—Effective Size in m.m.	.31	.285
Grain Characteristics—Uniformity Coeff.	1.50	1.50
Wash Brine & Rinse Water in per cent of plant output	10.5	6.5
Head	32	5

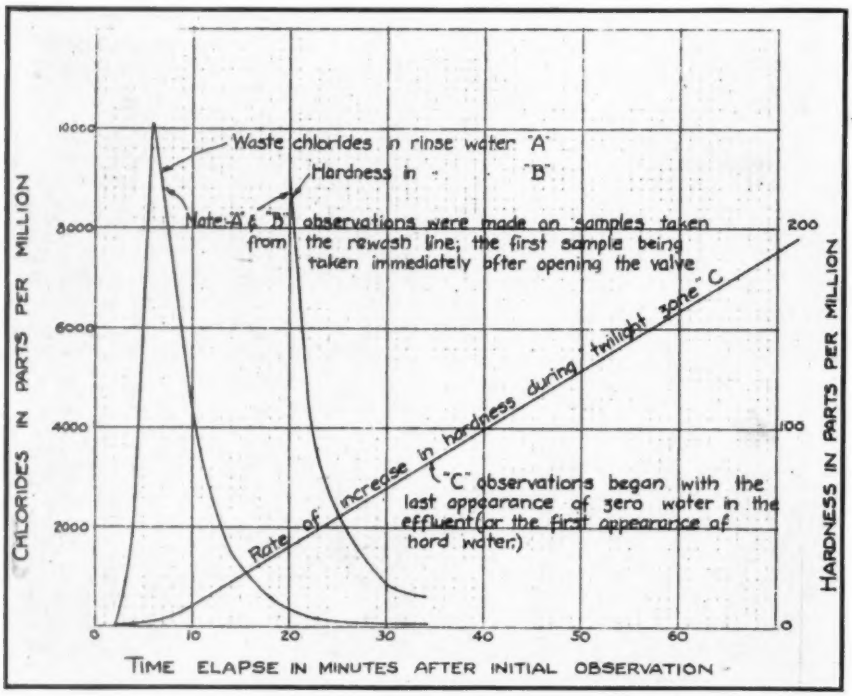

CHLORIDES IN PARTS PER MILLION
HARDNESS IN PARTS PER MILLION
Waste chlorides in rinse water "A"
Hardness in "B"
Note: "A" & "B" observations were made on samples taken from the rewash line; the first sample being taken immediately after opening the valve
Rate of increase in hardness during twilight zone "C"
"C" observations began with the last appearance of zero water in the effluent (or the first appearance of hard water)
TIME ELAPSE IN MINUTES AFTER INITIAL OBSERVATION

Fig. 4—Hardness and Chloride Changes During "Rinsing" and "Twilight Zone" Periods

The curve of sand rise for green sand during the washing period (Fig. 3) was obtained by lowering a series of test tubes, spaced at two in. intervals, into the space between the sand line and the wash trough, and noting the rise from the sand line to the highest tube in which the sand appeared for each given rate. The curve seems to correspond closely with other observations on quartz sand of similar grain characteristics.

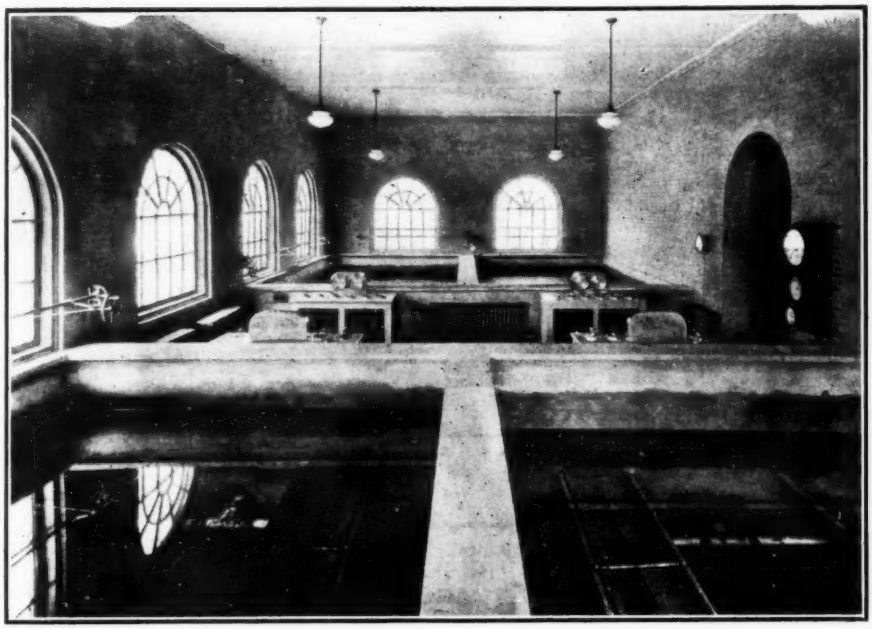
Hardness and Chloride Changes.—Certain technical data respecting the rinsing out of chlorides at the close of the regenerating period and of the action of the zeolite bed towards the end of the softening period are grouped in Fig. 4. At the start of the softening operation the fresh zeolite (or green sand), contains its maximum amount of sodium. As the "hard" water passes through the bed, an ionic exchange takes place through mass action such that the calcium and magnesium in the water "switch partners" with the sodium in the zeolite. For about 90 per

Table II.—Record of 15 Runs on Zeolite Softener Units

	Minimum	Maximum	Average
Hardness of raw water in p.p.m.	185	210	194
Harness of final product in p.p.m.	60	68	63
Length of soft water run in minutes	345	460	398
Length of "twilight zone" in minutes	95	150	123
Length of hard water period in min.	0	60	38
Length of total softener run in min.	495	645	559
Length of regeneration period in min.	20	40	37.7
Hardness removal in grains per cu. ft.	3700	4330	4004
Pounds of salt per 1000 gr. hardness removed	.361	.309	.334

cent of the time until full hardness appears, the bed turns out a water approximating zero hardness. During the latter 10 per cent of the period, or "twilight zone," the water changes from zero to full hardness according to a straight line relationship shown in Curve "C" of Fig. 4.

During the regenerating period there is a reversible reaction, such that the sodium of the brine solution enters the zeolite sand, displacing the calcium and magnesium which are "rinsed" out to the sewer as shown in Curve "A" of Fig. 4. The departure of calcium and magnesium is approximated by Curve "B." The six minute lag between the opening of the rewash valve and the maximum appearance of chlorides represents the waste of water (yet unbrined) which remained in the sand, gravel, etc., when the brine was applied.



Filter and Softening Units of Plant of Sewickley, Pa.

A Correction

In the article on the Design of Sprinkling Filter Distribution Systems published in the June issue there was an error in Formulas No. 1 and 2.

The formulas should read:

$$(1) \quad X = \sqrt{\frac{2(2^2+4^2+6^2 \ldots +N^2)}{N}}$$

$$(2) \quad Y = \sqrt{\frac{1^2+2^2+3^2 \ldots +N^2}{N}}$$

Sanitary Engineering Courses in the United States

A compilation of data concerning sanitary engineering courses in the colleges of the United States has recently been prepared by the United States Public Health Service. From this summary it appears that there are 16 colleges in the United States at present operating either regular or optional courses in sanitary engineering.

There seems to be considerable difference of opinion among the universities as to the fundamental conception of a sanitary engineering course. The sanitary engineering courses are in reality civil engineering courses with certain appended subjects, such as water supplies, sewage disposal, the bacteriology and chemistry of water and sewage, and a little public health instruction.

Emphasis in both sanitary engineering and public health subjects reflects in practically all the institutions the personality of the professor of sanitary engineering.

The number of sanitary engineering graduates annually is increasing. There is a great variation in the degrees granted by the institutions for equivalent work and also in the names of the courses. In four of the 16 institutions the term of the sanitary engineering courses is either five or six years.

The Model Traffic Ordinance

According to the National Safety Council eleven cities, including Indianapolis; Grand Rapids; Providence; Roanoke, Va.; Port Huron, Mich.; Alton, Ill.; Findlay, Ohio; Boston; Hinton, W. Va.; Fort Dodge, Ia., and Great Falls, Mont., have adopted exactly, or substantially, the Model Traffic Ordinance drawn by the National Conference on Street and Highway Safety. Los Angeles, San Francisco, and Chicago adopted ordinances substantially the same while the model ordinance was in process of formation.

The California Model Ordinance, prepared before and substantially the same as the Model Ordinance, has been adopted by 92 cities in California.

The Michigan Model Ordinance, which is also in substantial agreement with the Model Ordinance, has been adopted by 215 cities and villages in that state.

New Jersey has incorporated most of the provisions of the Model Ordinance in a state law which is thus operative for all municipalities. South Dakota has also adopted Act IV of the Uniform Vehicle Code practically verbatim and this went into effect July 1st for all municipalities in the state.

Municipally-Owned Boiler Plants Must Pay Inspection Fee.—Municipally-owned steam boilers used in plants operated by cities and towns of Arkansas are subject to the payment of the regular inspection fees to the state as are paid by individual owners, it was held in an opinion issued by Attorney General Hal L. Norwood at the request of J. D. Newcomb, chief boiler inspector in the state department of labor. The opinion, which was written by Assistant Attorney General Robert F. Smith, was handed down when the state's right to collect such charges was questioned by Mayor Pat L. Robinson of Little Rock on the contention that the state cannot legally tax one of its political subdivisions. Payment of a bill rendered by the boiler inspection department of the labor department covering inspections of boilers used in Little Rock municipally-owned plants was refused by the city on this interpretation of Act No. 228 of 1927, which requires the inspection of steam boilers within the state as a safety measure. The fees pay the expense of such inspections.

Missouri Valley Water Works to Meet in November.—The 15th annual meeting of the Missouri Valley Section of the American Water Works Association, will be held at Sioux Falls, S. D., on November 6, 7, and 8. R. Rees, Superintendent of the Sioux Falls Water Works, will be in charge of the local arrangements. The office of E. Waterman, the Secretary, is Room 104N, Engineering Building, State University of Iowa, Iowa City, Ia.

Pump Discharge Headers and Pump Piping for Water Works Stations

A Valuable Discussion of a Much Neglected Topic

By F. G. CUNNINGHAM
Of Fuller & McClintock, Engineers, New York City

PROBABLY few important features of water works practice have been so neglected and have been developed in such disregard of sound engineering practice as the piping arrangements used to connect the pumps with the outgoing supply mains, commonly referred to as "header systems." Probably not over one out of ten such systems, as installed, is arranged so as adequately to safeguard reliability of service and obtain maximum reliability consistent with the number of valves and fittings used.

Effect of Local Conditions.—Consideration of this subject in a specific case must take account of varying local conditions that cannot be dealt with in a general discussion such as this. For example, the presence and amount of elevated or hill-top storage beyond the high service pumps has a direct bearing upon the problem. With enough such storage for many days' demand, meager and poorly arranged piping arrangements might still furnish reliable service. Also the number of pumps and of supply mains included in the layout and the number that can be spared without crippling service will influence somewhat the required header arrangements. On the other hand it is obviously unwise deliberately to install header arrangements that might result in shutting down several pumps or several lines even in cases where they might be spared, when a comparatively nominal extra expense or more skill in the arrangement would render such shut-downs unnecessary.

Since most cities have comparatively little or no storage of pressure water, we may assume that for a typical case such storage is absent or too small greatly to be relied upon. Where a considerable amount of it is present the supply that might be obtained from it may be considered in conjunction with that available from the pumping station at the time of the most serious break in the system of header piping, and to that extent might modify the statements about to be made in this paper.

Meeting the Maximum Demand.—Any station should be at least capable of meeting the maximum domestic demand plus fire draft with the largest pump out of service. Preferably this capacity should be available with the two largest pumps out of service, due to the various conditions such as routine repairs, breaks in steam piping or valves or things of that sort to be expected. Most stations have at least one spare pump and many have two, but few have more. Whatever the number of spare units may be, the writer would point out the obvious inconsistency in providing piping arrangements that might readily throw out of service more than the number of pumps that can be spared. It is also desirable and in some cases strictly necessary that full domestic and fire service be maintained with one of the supply mains, or the portion of it necessarily dewatered in repairing any valve, out of service. Considering these factors and the variations in pumping demand normally to be expected, not less than three pumps and three supply mains are required to present an entirely flexible and satisfactory layout for any case where pressure storage is small or absent.

Functions of Good Discharge System.—The functions of a good discharge header may be summarized as follows:

(a) To permit any pump, pipe or valve to be isolated for repairs without crippling service.

(b) To permit any or all pumps to deliver to any or all supply mains, or at least reasonable flexibility in this respect.

(c) To allow of ready operation of essential control valves, especially in emergencies.

(d) To provide convenient access for inspection and repair of control valves and connecting pipes.

(e) To provide reliable and multiple points of connection for essential small water pipes for station service.

The repair or replacement of a valve in a header system is naturally more serious than that of a piece of pipe, since it involves two runs of pipe, that is one on each side of the valve, instead of one run. It is essential, then, to provide two valves between any two adjoining pump connections or supply main connections if it is desired to avoid shutting down more than one unit or line with a single break. With these facts and the above mentioned functions of a good header in mind it is interesting to examine diagrams showing some actual or typical header layouts.

Header Layouts.—Figure 1 shows a flagrant case of poor arrangement actually installed in a recent project. The entire battery of pumps is connected to a single suction main and a single discharge main without valves except on the branch connections to the pumps. The repair of any piece of pipe in suction or discharge lines or of any valve would put the entire station out of service.

Figure 2 shows two pumps and two lines with two valves between pumps. One pump and one line would be shut down by any break or any valve repair. If it were not for the two valves between the pumps the entire station would be shut down. This layout is of interest principally in showing that the number of pumps and of lines is too small.

Figure 3 shows three pumps and two lines of which two pumps and one line would be put out of service by repairs to valves "A" or "B."

Figure 4 shows the same thing except that there are two valves between adjoining pumps making it unnecessary to shut down more thon one pump and one line with a single break.

Fig. 5 shows a three pump layout containing six valves and with a poorly arranged cross connection. Repair to valve "A" would put out of service two pumps and one line. In Fig. 6 is shown a good layout having the same number of pumps, lines and valves, and with each pump discharge split into a separate valved connection leading to each main. With this arrangement the most serious break cannot shut down more than one pump and one supply main, which result would occur through the repair of any one of the six valves. Fig. 7 shows another way of accomplishing the same results as in Fig. 6 and with the same number of valves. The consequences of the most serious valve repair are the same as the Fig. 6, except that the chances of such occurrence are somewhat less since there are only four valves that can produce that result instead of six.

Fig. 8 shows substantially the same arrangement as Fig. 7 except that additional valves are inserted bringing the total number up to 11. Under this arrangement two advantages are gained as compared with the others. First, while the repair of certain valves can shut down either one pump or one supply main, no single repair can shut down both a pump and a supply main. Second, connections are such that there is less likelihood of emergencies re-

quiring the stopping of one pumping unit and the starting of another, which operation might be embarrassing.

Fig. 9 shows the header layout designed by the writer's firm for Memphis, Tenn. The effect of the most serious single break or repair would be to put one pump or one supply main out of service. Due to the arrangement of cross connections it is possible in this layout to continue pumping to all of the mains with all pumps except the one that might be directly affected by a break, thus cutting down the chance of having suddenly to start up a new unit as above mentioned.

Fig. 10 shows a layout devised by the writer in connection with work at Kansas City, Mo. It can be expanded or contracted indefinitely to fit any number of pumps or supply lines. It is founded upon the reasonable basis that one pump and one supply main but not two pumps or two mains may be put out of service simultaneously without impairing service. The features of this arrangement are the way in which the pump discharges and the supply mains alternate in their point of connection to the header and the use of the run-around pipe which may be placed under or above the supply mains or discharge mains. For the number of valves and fittings required this arrangement provides at least as much reliability and flexibility as any arrangement the writer has so far encountered. As compared with the Memphis layout shown in Fig. 9, it provides for the same number of pumps and one additional supply main and requires only ten valves and nine tees instead of 18 valves and 12 tees. By adding eight more valves, that is placing two valves instead of one between each pump connection and the adjoining supply connection, the most serious break would shut down only one pump or one supply main instead of both the pump and supply main, giving substantially the same result as at Memphis.

The arrangements shown in Fig. 9 and 10 make unnecessary the providing of valves in the individual discharge pipes from the various pumps, because any pump can be isolated by closing the header valves lying on either side of the tee for the pump connection.

Fig. 11 differs from Fig. 10 in that the pump discharges and supply mains are in line, doing away with the offset at the header. Without the offset higher velocities and smaller valves and pipes might be used with distinct advantage. The valves in the individual pump discharge pipes are more necessary in this case than in Fig. 10 because without them a supply main would be shut down whenever a pump was opened for repair or inspection. This arrangement is at its best when the number of pumps and number of supply mains can be made equal, as they often can be by a little planning.

Fig. 12 shows another application of the idea already illustrated in Fig. 6, that is, of splitting each pump discharge into two pipes each leading to a different supply main. Fig. 12 is equivalent, as regards the number of valves and the results produced by the repair of a valve, to Fig. 10 or to Fig. 11 if the valves in the pump leads of the latter be omitted. It might be more convenient or economical than either of these in some cases.

Fig. 13 shows the header arrangement actually installed in a large city having the same number of pumps and supply mains as illustrated in Figs. 10 and 12. The interesting points about this layout are the unskillful use which has been made of the number of valves and fittings installed and the failure to provide adequately for maintaining service. Thus repair to valve "A" would shut down three pumps which comprise 75 per cent of the station capacity. Repair to valve "B" would shut down three of the four supply mains. Other combinations would shut down one pump and two supply mains or vice versa. It is interesting to note that by using one of the arrangements shown in Figs. 9 to 12 much better results

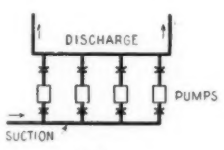


FIG. 1
A POOR HEADER ARRANGEMENT

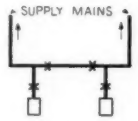


FIG. 2
ONE PUMP AND ONE LINE BY ANY BREAK OR VALVE REPAIR

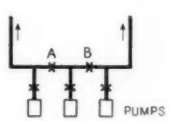


FIG. 3
ONE PUMP AND ONE LINE BY SINGLE BREAK IN LINE
2 PUMPS AND ONE LINE BY VALVE REPAIR

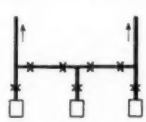


FIG. 4
ONE PUMP AND ONE LINE BY REPAIR OF LINE OR VALVE

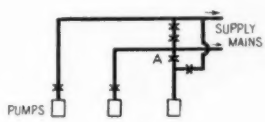


FIG. 5
ONE PUMP AND ONE LINE BY SINGLE BREAK IN LINE
TWO PUMPS AND ONE LINE BY REPAIR OF A VALVE

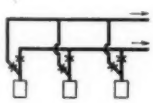


FIG. 6

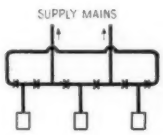


FIG. 7

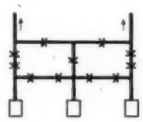


FIG. 8

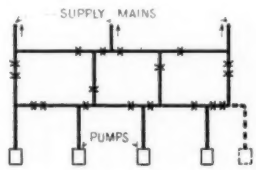


FIG. 9
MEMPHIS, TENN. HEADER
NO SINGLE BREAK OF PIPE OR VALVE CAN PUT OUT OF SERVICE MORE THAN ONE PUMP OR ONE SUPPLY MAIN

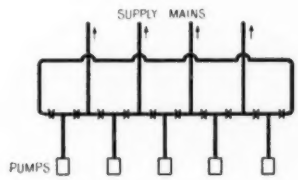


FIG. 10
A GOOD TYPE OF HEADER
WORST BREAK PUTS OUT OF SERVICE ONE PUMP AND ONE SUPPLY MAIN

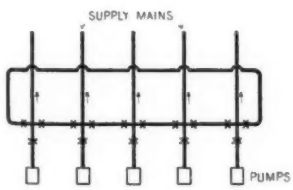


FIG. 11
FIGS. 11 AND 12 PROVIDE SAME DEGREE OF PROTECTION AS FIG 10

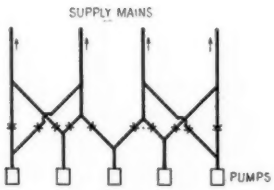


FIG. 12

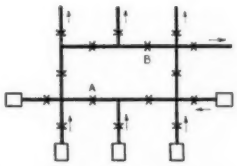


FIG. 13
ACTUAL HEADER IN A LARGE CITY
REPAIR OF VALVE "A" PUTS OUT OF SERVICE 3 PUMPS OR 75% OF STATION CAPACITY
REPAIR OF VALVE "B" PUTS OUT OF SERVICE 3 OF THE 4 SUPPLY MAINS.

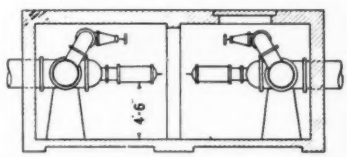


FIG. 14
SECTION OF MEMPHIS HEADER CHAMBER

Figs. 1 to 14—Diagrams Showing Actual or Typical Header Layouts

would have been secured with five less valves and fewer fittings. Or stated in another way, by using three more valves than were actually used and by changing the arrangement it would have been possible to have kept everything in service except one pump or one supply main in the event of the most serious break of a valve.

Most designs could be improved by using more and smaller pumps and mains, particularly the latter. It is often noted that two large mains lead from a station and soon subdivide into say four smaller ones, when at slight cost all four mains could have been led directly from the header, with much greater reliability and flexibility.

Header Details.—In a few places in an effort to secure the utmost reliability, the pipe and fittings in the header systems have been made of rolled steel and the valves of cast steel. The writer believes that as a rule this expensive practice is unnecessary, and is of the opinion that in a suitably arranged header cast-iron fittings and valves are satisfactory. Both fittings and valves however, should be especially rugged and designed for a pressure considerably in excess of the working pressure on the header system.

Where the fittings are larger than 16 in. in diameter it is a good plan to have each of them tapped and plugged at a number of points to make sure that the casting is not unduly eccentric or thin on one side. This precaution is worth while in view of the fact that special castings are not ordinarily put under a pressure test or measured for wall thickness in the foundry. To avoid danger of joints pulling apart it is best to make all of the pipe and valves in the header system flanged. In layouts such as that shown in Figs. 10 and 11 the run-around pipe, since it contains no branches, can be made of steel.

In order to make all parts of the header readily accessible the header should be enclosed in a masonry chamber, with convenient access provided from the pumping station and from the surface. Fig. 14 shows a section of the header used at Memphis, the plan layout of which is shown in Fig. 9. The header system is 24 in. in diameter throughout. The valves are operated hydraulically from a control table located inside of the pumping station near the front wall. The operating water for the valve cylinders is supplied ordinarily by water from the discharge mains, but the boiler feed pumps are also connected to the operating table through a reducing valve for emergency use. When a lever is moved to operate a valve the waste water flows from a pipe at the back of the table and into a funnel connected to the sewer, giving the operator a visible indication when the valve is moving and when it has stopped moving. Except when the table is in use the water supply and water waste connections to the table are kept cut off by valves controlled from the top of the table, for the purpose of preventing unauthorized persons from tampering with the valves. A black line diagram similar to those shown here is framed and mounted at the back of the table and on it every valve is numbered so that the operator can secure a clear idea of what operations are required for any contingency.

Referring to Fig. 14, it will be noted that there is plenty of space below the header piping and valve cylinders to move any of the valves or fittings across the floor to a point underneath one of the hatchways in the roof. Without this space the removal or insertion of a fitting would be quite difficult. Valve cylinders are all placed horizontally so that there is no tendency for the valves to creep when the pressure is cut off from the cylinder. The bypass valves are all placed on top of the main valves and with the operating stems projecting inward toward the center of the loop so that they all can be reached without climbing over the header piping. A large drain leads from one corner of the header chamber to the sewer so as quickly to carry off water that might come from a break in the header system or the pumping station basement.

The Memphis layout illustrates how the various requirements for ready and convenient operation and for access to the header were met in this one case. Whether hydraulic or electric valves should be used in a given case as against hand operated valves, depends considerably upon the number and size of the valves, but there is no doubt that even in small sizes power operation is advantageous and will speed up the valve operations necessary in emergencies. Hydraulic valves are cheaper than electrically operated valves and if connected to the boiler feed pumps or some similar emergency source of water supply, are probably more dependable as to source of power supply in most stations.

It is often advantageous to use high water velocities and relatively small pipe and valves in the header system. This not only keeps down the cost but promotes quickness of operation, ruggedness and reliability as compared with larger piping. In any of the loop arrangements such as shown in Fig. 10, water ordinarily flows both ways around the header, and normally velocities are moderate. When the loop is interrupted by closing valves, velocities will be high, but considering the short time such conditions exist and the advantages to be gained by the smaller sizes a few feet of extra head loss is not a powerful factor.

Except as the need for reliability may be modified by the pressure of low service storage, low service discharge headers should be laid out with the same care as high service headers.

Suction Connections.—On account of the low pressure on the suction side of the pumps and of the greatly lesser likelihood of breaks occurring there, it is unnecessary to have suction arrangements anything like as thoroughly valved and as complex as the discharge header. There are certain criteria, however, which should be met. The suction connection from each pump should lead directly to the suction well or to a concrete conduit, which may be regarded as the equivalent of a suction well, independently of the other pumps. The suction pipe for each pump should project several feet below the lowest water level in the suction well or suction conduit so that the pump may be primed or started or stopped without interfering with the suction to the other pumps. If these requirements be met about the only other requirement to be considered is that it should be made possible to gain access to one part of the suction well or suction conduit and to the individual pipes connected thereto without interrupting service of the remaining pumps. At Memphis there are two separate suction conduits, one arranged to supply three pumps and the other two pumps. Each conduit is controlled by a sluice gate and each sluice gate by double stop-plank grooves, so arranged that either sluice gate or either suction conduit can be isolated without shutting down more than half of the pumps normally available.

Under other circumstances the same effect could be produced with a single suction conduit merely by placing stop-plank grooves at intervals along the length of the conduit and by feeding the conduit from both ends. This is done in the Dallas design where the grooves divide the conduit into three parts, and where the grooves are covered with plates set flush with the basement floor and designed to take the uplift of a full clear water basin. In this case the basin will be lowered when the conduit is to be entered.

The above described suction arrangements are probably sufficient for the average case. For one thing they eliminate the most common fault in suction piping which is to connect the pumps to a single vacuum suction header invariably resulting in troubles in priming the pumps or in keeping them primed during operation.

Foot valves in suction connections are to be avoided, first, because they introduce in an inaccessible location a device likely to require attention and repair, and second, because they are likely to subject the pumps and suction piping, especially centrifugal pumps, to severe shocks caused by water hammer when the checks close.

Check Valves.—Check valves on the discharge side of centrifugal pumps are practically essential in all ordinary cases. In one case where they were omitted a sudden tripping of the pump, and the resulting back flow of water at

high velocity, burst the pump casing. Another danger when check valves are omitted is that the back flow of water will over-speed the pump and cause damage through centrifugal stress before it can be shut off.

For these reasons check valves in the discharge lines of centrifugal pumps seem to be a necessary evil, although the way in which some of them slam shut and cause water hammer when the power it cut off, is a matter of concern to many operators, particularly where the valves are 24 in. or more in diameter. Relief valves should be provided where the danger of hammer is great. After experiencing this difficulty in a number of installations, the writer took up with a valve manufacturer the question of designing a valve which would close with less shock. A multiport valve was required and it was decided to depart from the standard design of that manufacturer to the extent of increasing the number and cutting down the diameter of the ports and making the flaps of a tough bronze instead of bronze faced cast iron. The reduced weight of the flaps and the reduced distance through which they traveled in closing apparently produced a good result as these particular valves close without noise even when the pump is suddenly tripped. Of course, the Larner-Johnson, Automatic Cone or other special combination stop and check valve can also be used to prevent hammer and can be used in sizes much too big for a good gate or check valve. The writer has seen fit to mention this detail because the shocks in many such lines are a serious potential source of unreliability.

The foregoing discussion of headers and pump piping is offered on the basis that it may point out proper methods of approaching the subject rather than with the idea that it will afford a suitable layout fitted to each particular case. Local conditions must be considered in all cases. In every case, however, authorities responsible for planning the piping arrangements should submit their proposed arrangements to the insurance inspection department having local jurisdiction. In all cities above 25,000 population, the National Board of Fire Underwriters, through its Engineering Department, makes a detailed study of the entire water system and it is highly desirable that their criticisms should be secured before the work is built. They are in possession of an abundance of information and know the good and bad features of all important water systems in the country as viewed particularly from the standpoint of reliability of service.

Acknowledgment.—The foregoing is an abstract of a paper presented June 25 at 49th annual convention of the American Water Works Association.

Wages and Hours of Labor of Common Street Laborers in 1928

The entrance wage rates and regular hours of labor of unskilled street laborers directly hired by more than 2,600 cities and towns in the United States have been compiled by the Bureau of Labor Statistics. The full compilation, giving details by individual communities, will appear in bulletin form. A brief summary of this report is given in the June Monthly Labor Review, a publication of the U. S. Department of Labor.

The rates shown are those paid by the municipalities to common laborers when first engaged on the construction, repairing, or cleaning of streets. Higher rates may be paid for greater skill or after a period of service.

The questionnaires for this inquiry were sent out by the United States Bureau of Labor Statistics, under date of October 31, 1928, to all cities and towns having a population of 2,500 or over according to the 1920 census. About 93 per cent of these municipalities replied.

Classified Hourly Wage Rates.—In Table I are given classified entrance wage rates for common street labor, the number of municipalities in each state paying each classified wage rate, as well as the percentage of all municipalities paying each classified wage rate being shown. Of the 2,626 municipalities reporting, 593, or 23 per cent, were paying 40 and under 45 ct. per hour and 553, or 21 per cent, were paying 50 and under 55 ct. per hour. While 896 or about 34 per cent, paid under 40 ct. per hour, only about 15 per cent paid 55 ct. or more.

Classified Weekly Hours of Labor.—In Table II, classified working hours per week of unskilled street laborers are presented. The number of municipalities in each state whose laborers work each classified number of hours per week are shown, and the percentage of all municipalities whose street laborers work each specified number of hours per week are also set forth. Of the total cities and towns reporting, 1,053, or 40 per cent, had a 48 hour

Table I.—Classified Hourly Rates of Wages of Unskilled Common Labor Hired by Cities for Work in Constructing, Repairing or Cleaning Streets

State	Number of cities reporting	Number of cities in which hourly wage rates of street laborers were—														
		Under 15 cts.	15 and under 20 cts.	20 and under 25 cts.	25 and under 30 cts.	30 and under 35 cts.	35 and under 40 cts.	40 and under 45 cts.	45 and under 50 cts.	50 and under 55 cts.	55 and under 60 cts.	60 and under 65 cts.	65 and under 70 cts.	70 and under 75 cts.	75 and under 80 cts	80 and under 85 cts.
Alabama	33	....	9	14	6	4	....	....	....	....	....	....	....	....	....	....
Arizona	15	....	....	....	....	3	4	4	....	2	2	....	....	....	....	....
Arkansas	38	1	....	10	20	4	2	1	....	....	....	....	....	....	....	....
California	103	....	....	....	....	....	3	9	3	38	20	21	7	1	....	1
Colorado	26	....	....	....	....	....	7	11	2	4	1	1	....	....	....	....
Connecticut	30	....	....	....	....	....	2	3	6	12	4	1	1	....	1	....
Delaware	3	....	....	....	....	1	1	1	....	....	....	....	....	....	....	....
District of Columbia	1	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....
Florida	26	....	4	6	6	7	2	1	....	....	....	....	....	....	....	....
Georgia	54	2	23	19	6	2	2	....	....	....	....	....	....	....	....	....
Idaho	20	....	....	....	....	....	4	8	2	3	2	1	....	....	....	....
Illinois	166	....	....	....	1	10	16	32	10	39	12	14	10	3	17	2
Indiana	90	....	....	....	2	16	26	31	4	9	2	....	....	....	....	....
Iowa	79	....	....	....	2	12	17	34	5	8	....	1	....	....	....	....
Kansas	58	....	....	....	....	....	16	29	4	8	1	....	....	....	....	....
Kentucky	41	....	1	....	15	11	3	4	1	4	1	1	....	....	....	....
Louisiana	30	1	2	11	11	2	2	1	....	....	....	....	....	....	....	....
Maine	25	....	....	....	....	5	10	10	....	....	....	....	....	....	....	....
Maryland	18	....	....	....	1	4	4	4	3	2	....	....	....	....	....	....
Massachusetts	165	....	....	....	....	....	4	14	8	73	19	27	19	1	....	....
Michigan	92	....	....	....	....	6	14	36	12	17	3	3	1	....	....	....
Minnesota	56	....	....	....	....	8	15	15	3	10	4	1	....	....	....	....
Mississippi	29	....	2	11	13	1	2	....	....	....	....	....	....	....	....	....
Missouri	58	....	....	....	3	15	11	21	4	4	....	....	....	....	....	....
Montana	17	....	....	....	....	....	....	1	....	5	4	6	1	....	....	....
Nebraska	29	....	....	....	....	1	7	20	1	....	....	....	....	....	....	....
Nevada	2	....	....	....	....	....	....	....	....	1	1	....	....	....	....	....
New Hampshire	26	....	....	....	....	2	6	7	2	8	1	....	....	....	....	....
New Jersey	114	....	....	....	....	2	1	9	9	44	16	20	10	....	3	....
New Mexico	11	....	....	....	3	4	1	3	....	....	....	....	....	....	....	....
New York	162	....	....	....	....	....	5	40	20	57	11	15	7	....	7	....
North Carolina	52	....	....	15	30	6	....	1	....	....	....	....	....	....	....	....
North Dakota	12	....	....	....	....	....	3	8	1	....	....	....	....	....	....	....
Ohio	139	....	....	....	1	5	13	34	21	42	13	10	....	....	....	....
Oklahoma	58	....	....	....	2	9	9	28	1	8	....	1	....	....	....	....
Oregon	22	....	....	....	....	1	1	4	1	10	3	2	....	....	....	....
Pennsylvania	292	....	....	....	1	7	28	88	54	90	19	5	....	....	....	....
Rhode Island	21	....	....	....	....	....	2	5	4	8	2	....	....	....	....	....
South Carolina	30	....	13	16	1	....	....	....	....	....	....	....	....	....	....	....
South Dakota	14	....	....	....	....	....	3	8	2	1	....	....	....	....	....	....
Tennessee	39	....	2	12	20	2	2	1	....	....	....	....	....	....	....	....
Texas	106	....	8	5	28	26	17	16	1	4	....	....	....	1	....	....
Utah	15	....	....	....	....	....	8	4	....	2	1	....	....	....	....	....
Vermont	14	....	....	....	....	1	4	7	1	1	....	....	....	....	....	....
Virginia	38	....	....	....	19	11	6	2	....	....	....	....	....	....	....	....
Washington	33	....	....	....	....	....	....	3	....	17	7	6	....	....	....	....
West Virginia	34	....	....	....	1	7	2	13	3	8	....	....	....	....	....	....
Wisconsin	82	....	....	....	3	6	28	20	10	10	3	2	....	....	....	....
Wyoming	8	....	....	....	....	....	....	1	....	4	2	....	....	1	....	....
Total	2,626	4	64	119	195	201	313	593	198	553	154	137	57	7	28	3
Per cent	100	(1)	2	5	7	8	12	23	8	21	6	5	2	(1)	1	(1)

Table II.—Classified Hours per Week Worked by Unskilled Common Labor Hired by Cities for Work in Construction, Repairing or Cleaning Streets

State	Number of cities reporting	Number of cities having working week of—							
		44 hours	Over 44 and under 48 hours	48 hours	Over 48 and under 54 hours	54 hours	55 hours	Over 55 and under 60 hours	60 hours
Alabama	33		1	3	2	5	6	7	9
Arizona	15			15					
Arkansas	38	1	1	7		8	5	2	14
California	103	25	3	73		1			1
Colorado	26			25					1
Connecticut	30	4	1	9	9	7			
Delaware	3		1		1				1
District of Columbia	1			1					
Florida	26	1	2	5	3	6	3	1	5
Georgia	54	1	1	1	8		18	6	19
Idaho	20			20					
Illinois	165	[1] 26	5	68	21	29	1		15
Indiana	90	2	2	18	14	19	9	1	25
Iowa	78	3		19	3	19		2	32
Kansas	58	1		55		1			1
Kentucky	41	[1] 6	1	7	5	10			12
Louisiana	30	2	1	2	2	10	1	2	[2] 10
Maine	25	1		5	2	17			
Maryland	17	2		5	7	2			1
Massachusetts	164	[1] 43	12	93	9	6	1		
Michigan	92	1	6	12	17	31		2	23
Minnesota	55	1	1	19	1	8		1	24
Mississippi	30	1	1	5	3	6	1	4	9
Missouri	58	3		23	5	15		1	11
Montana	17			16					1
Nebraska	29			16		2			11
Nevada	2			2					
New Hampshire	26			7	5	14			
New Jersey	114	27	13	36	29	8	1		
New Mexico	11	2		8	1				
New York	161	31	11	89	5	18			7
North Carolina	52			1	3	1	29	2	16
North Dakota	12			6					6
Ohio	139	25	15	72	7	8	4		8
Oklahoma	58	[3] 1	1	54					2
Oregon	22	1		21					
Pennsylvania	290	14	16	74	70	58	33	9	16
Rhode Island	21	2	1	3	6	8			1
South Carolina	30			1	4		17	1	7
South Dakota	14			2		6			6
Tennessee	39	1	1	3	4	5	12	1	[3] 12
Texas	106	[1] 9	4	75	6	6		2	4
Utah	15			14				1	
Vermont	14		1	2	2	9			
Virginia	38	2	2	2	11	6	9	1	5
Washington	33	2	2	29					
West Virginia	34	1	2	9	5	12			5
Wisconsin	82	[4] 3	1	13	12	17	4	3	29
Wyoming	8			8					
Total	2,619	[5] 245	109	1,053	282	378	154	49	[6] 349
Per cent	100	9	4	40	11	14	6	2	13

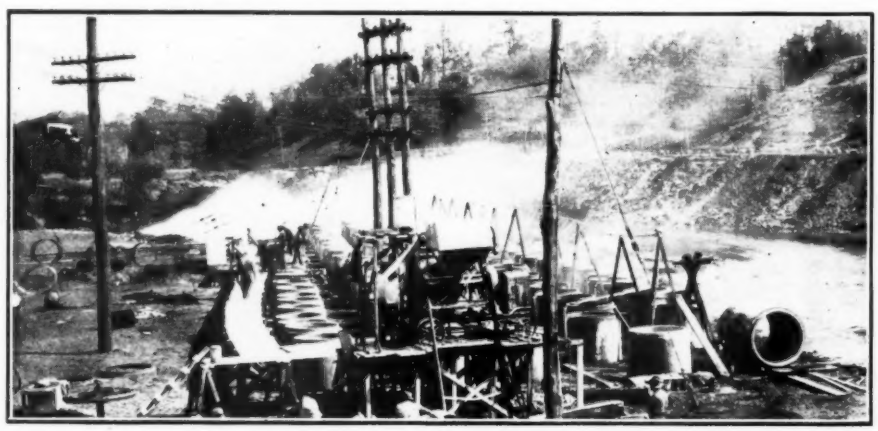
[1] Including 1 with less than 44 hours per week.
[2] Including 1 with more than 60 hours per week.
[3] Less than 44 hours per week.
[4] Including 2 with less than 44 hours per week.
[5] Including 7 with less than 44 hours per week.
[6] Including 2 with more than 60 hours per week.

week and 13 per cent a working week of less than 48 hours. On the other hand, 46 per cent had a working week of over 48 hours. While the street laborers in 9 per cent of the cities worked 44 hours or less a week, in 13 per cent of the cities such laborers had a 60-hour week.

Rotating Overhead Spray Cures Precast Concrete Sewer Sections

A new sewer under construction in Waterbury, Conn., is of considerable interest because of its location in the bed of the Naugatuck River. The sewer is of precast concrete construction, the units being 54 in. in diameter and 4 ft. long.

Because of the location of the sewer under water, particular care was taken to secure an impervious concrete of high strength. Proper curing was deemed especially important. The accompanying photograph shows the casting yard, illustrating the method of curing the finished sections. Simple A-frames were set up with roller bearings at the tops. A line of perforated pipe was laid upon these roller bearings and connected at the end with a small water motor of the type used to rotate large lawn sprinklers. When water was turned through the piping, it fell in sprays, keeping the curing sections in a cloud of moisture. The sprinkling was carried on continuously—day and night. During the daytime the spray was supplemented by a boy with a hose, who patrolled the units and sprinkled portions of the concrete pipe not reached by the spray. The photograph was taken shortly after the manufacture of the pipe was begun and shows only one line of sprinkler pipe. Later two and three lines of pipe were used so that the precast pipe could be kept thoroughly wet for 10 days in accordance with the requirements of the specifications.



Sprinkler System Used for Curing Precast Concrete Sections for Naugatuck River Sewer in Waterbury, Conn. The Overhead Rotating Spray System Was Found Very Effective in Securing Proper Curing

As shown in the illustration, the mixer was placed on a platform at the end of rows of forms. Concrete was transported on a raised runway. Concrete was usually placed in the forms between 10 and 2 o'clock, and it had usually set sufficiently to allow removal of the forms by the next morning. The forms were then stripped and the pipe was moved into line below the sprinkler for curing.

The pipe used in this project is being manufactured by the Newark Concrete Pipe Co., of Newark, N. J. The sewer is being built under the direction of Robert A. Cairns, City Engineer of Waterbury, with Truman M. Curry, Jr., Assistant Engineer, in charge of design, location and construction work.

Air-Port Design Competition

The Lehigh Portland Cement Company is sponsor of a competition for the design of a modern air-port, details of which may be obtained by writing the company at Allentown, Pa. The competition will close Nov. 18, 1929. Engineers, architects and city planners may compete. Entries consist of two sheets, each containing two principal drawings. Fourteen cash prizes aggregating $10,000 will be awarded, as follows:

First prize	$5,000
Second prize	2,500
Third prize	1,000
Fourth prize	500
Ten honorable mentions, each	100

Acquiring the Research Habit

By HALBERT P. GILLETTE

KNOWLEDGE consists in knowing facts; wisdom, in knowing their relationships. Perhaps this is a rather arbitrary distinction between these two words, but it serves at least to emphasize the difference between mere fact gathering and the discovering of the significance of facts.

"Those who refuse to go beyond a fact rarely get as far as fact," said Huxley, and he added, "anyone who has studied the history of science knows that almost every great step therein has been made by the anticipation of nature, that is, by the invention of hypotheses which, though verifiable, often had very little foundation to start with."

In a letter written in 1861 Charles Darwin said: "About 30 years ago there was much talk that geologists ought only to observe and not theorize; and I well remember someone saying that at this rate a man might as well go into a gravel pit and count the pebbles and describe the colors. How odd it is that anyone should not see that all observation must be for or against some view if it is to be of any service." At another time he said "I am a firm believer that without speculation there is no good and original observation."

Coming from a man who was one of the most painstaking of observers and experimenters, and the author of a theory that is without equal in its effect upon biological science, such an attitude toward the framing of scientific hypotheses is not to be brushed aside. Darwin's biographers all say that he was exceptionally prolific in devising hypotheses to explain phenomena. One of them quotes him as saying: "Hence it has become a passion with me to try to connect all such facts by some sort of hypothesis." And again: "I have steadily endeavored to keep my mind free so as to give up any hypothesis, however much beloved (and I cannot resist forming one on every subject), as soon as the facts are shown to oppose it." However, he did not live up literally to this last statement, for several times when his theory of evolution seemed to be seriously controverted by certain facts, he clung to it. Many a competent naturalist, such as Agassiz, cited many a fact that seemed to be unanswerable by Darwin's theory, yet Darwin adhered to his belief in its fundamental soundness. Apparently he reasoned that a new theory should be judged mainly by what it explains rather than by what it fails to explain.

The doctrine that was prevalent a century ago among geologists and astronomers, to which Darwin made reference in the letter above quoted, still controls not a few scientists. Recently an experienced astronomer wrote the editor that the time is not yet ripe for theorizing about the origin of our solar system. If Darwin is right, the time was ripe for such theorizing when Galileo made his telescope. Commenting directly upon such matters. Darwin said: "How many astronomers have labored their whole lives on observations, and have not drawn a single conclusion."

In a letter written in 1871 he says: "I have been speculating last night what makes a man a discoverer of undiscovered things, and a most perplexing problem it is. Many men who are very clever—much cleverer than the discoverers—never originate anything. As far as I can conjecture, the art consists in habitually searching for the causes and meaning of everything which occurs."

There is a world of truth in this last statement, but the word "habitually" should have been printed in capitals. How to become an habitual seeker of causes and meanings is a great problem. Darwin not only denies that his training in two universities failed to make him such a seeker, but he asserts that his university time was mostly wasted: "During the three years which I spent at Cambridge my time was wasted, as far as the academical studies were concerned, as completely as at Edinburgh and at school." He was born in 1809, and when he was at Cambridge physical science was little taught. Yet it is rather surprising to hear so modest a man say: "I consider that all I have learnt of any value has been self-taught." Surely he did not have in mind what he learned from books, but regarded that as part of his self-taught knowledge. The opening chapter of his "Origin of Species" contains many references to books and articles by men who had had more than mere glimpses into the secrets of evolution, and his biographers tell of his painstaking indexing and abstracting of books and articles throughout his long and industrious life. We are, all of us, prone to regard what we learn in that manner as being "self-taught." Henry Ford, in his book, makes the same error, for he speaks of his careful reading of all that could assist him in designing automobiles, and then adds that he learned most from his own experiments. That he learned most from published matter is beyond question when consideration is given to what he himself added to the art of automobile designing.

When we see what Darwin accomplished without much aid from his university training, and what Ford accomplished with no such aid, and remember that many another originator and inventor has succeeded greatly in spite of little scientific schooling, it should be evident that most of science can be learned from books and articles, without the assistance of teachers. Moreover, it is almost self-evident that any studious man of middle age has necessarily learned vastly more from the printed page after his formal schooling ended than he learned at school.

Darwin's rebellious attitude toward Cambridge may have come from his perception that Cambridge did nothing to make him an habitual inquirer as to the causes of things. If so, then most of our American graduates of colleges and universities could justify a similar rebellion. We have yet a long road to travel in America before it is generally realized that the primary function of schooling is to make the students habitual inquirers. Only in a few American institutions of higher learning is training conducted continuously so as to effect that result. Studying the fundamental principles of science does not accomplish that result. Mathematical training does not. Then what does? Nothing but repeated practice in systematic searching for the answers to questions, and particularly to questions that can be answered only by the collecting and weighing of many facts.

If it be objected that we can not all be Darwins or Fords, and that such men will always find ways of training themselves, then the objector has completely failed to understand the primary object of mental training. It is not to acquire knowledge, or even to acquire wisdom, that we take courses of study in college, for neither is acquirable to any considerable extent during the schooling period. It is to become habituated to secure and analyze facts with a view to answering some definite question.

The question may be, What is the most economic pavement to lay for the service that it will probably be required to render? Simple though it sounds, this is a very difficult problem in many cases. The question may be, What business or profession should I enter and where? More than 99 per cent of men guess at the answer, for they have never been habituated to solve problems by the fact-gathering method. The question may be, Why is my business unprofitable although my competitor is thriving? No solution is there for such a problem other than fact-gathering and analysis. Nearly all the problems in life are of these sorts, and then solution is correctly made only by those who are either instinctively fact-hounds, or have become habituated to searching for usable facts and their significance.

Mechanical Developments in Water Treatment Practice

Use of Mechanical Clarifiers and Agitators in Water Treatment

By C. T. LEANDER
Branch Manager, The Dorr Co.

IN this paper the discussion will be confined to the unit operations of presedimentation, sedimentation, chemical softening and chemical coagulation, their relationship one to another, and their relationship to the other unit operations in several typical flowsheets which have been found effective in the case of three frequently encountered treatment problems.

The mechanical equipment for carrying out these unit operations which we are qualified to discuss, are the Dorr traction clarifier and the Dorr impeller agitator.

The Clarifier.—The Dorr Traction Clarifier, as shown in the accompanying illustration, is a continuously cleaned sedimentation basin which, when receiving as its feed raw or chemically dosed water introduced through submerged ports along the influent side, overflows continuously a clarified water across a weir at the effluent side opposite and discharges a thick sludge from a bottom connection. It operates continuously, is never shut down for manual cleaning and duplicate or stand-by units are not needed. The total tank contents are at all times available for detention purposes as sludge is removed at the rate of deposition. The old device which it displaces is the well known settling basin, rectangular in shape and constructed of concrete and masonry.

The Agitator.—The Dorr impeller agitator was developed to satisfy the conditions prevailing in water treatment, that is, effective turnover of the raw water to give homogeneity throughout but at a velocity at which flocs will form and build up rapidly. The illustration of a cross section through such an agitator is almost self explanatory. A slowly revolving marine impeller in a cylindrical draft tube induces a gentle circulating motion of the tank contents, upward through the tube and downward in the annular space surrounding it. A velocity between .5 ft./sec. and 1.5 ft./sec. is maintained as at this velocity flocs build up readily, yet do not settle on the tank bottom. In order to insure complete treatment of all the water with a minimum of short circuiting, two or three agitator tanks, arranged in series, are recommended. Vertical baffles, at right angles to the flow line between influent and effluent ports, and extending from the bottom to slightly above the water level, minimize swirling and cause all of the water to pass through the draft tube at least once.

These Types of Treatment.—With this brief outline of the salient features of the clarifier and agitator, consideration may be given to the development of flowsheets for handling the following three common problems:

	Character of Raw Water	Treatment	Chief Unit Operations
1.	Turbid and soft	Clarification	Coagulation Mechanical sedimentation (Plain sedimentation) Filtration
2.	Clear and hard	Softening	Softening Mechanical sedimentation Plain sedimentation Filtration
3.	Turbid and hard	Clarification Softening	Mechanical presedimentation Coagulation and softening Mechanical sedimentation Plain sedimentation Filtration

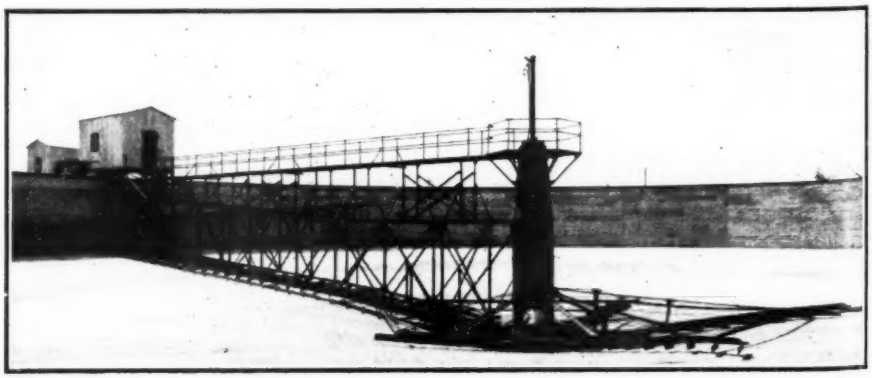
These three types of treatment are well known. It is conservatively estimated that they cover 80 per cent of the problems encountered in water works practice. Simple as they are, they have been the subject of much study by the leaders in the development of modern practice, as Hoover, McDonnell, Graf, Flemming, to mention only a few, have been instrumental in moulding practice in each case to a point where chemical and mechanical controls approach very closely to perfection. As this paper cannot attempt to deal with all phases of improved technique, it will attempt simply to show the relationship of mechanical clarifiers to each of these three common problems, quoting operating figures at typical installations insofar as possible.

Turbid, Soft Water.—Water containing excessive amounts of suspended solids, yet in other respects, such as hardness, suitable to domestic and industrial use is found chiefly along the seaboard as distinguished from the great hard water section in the mid-western and central portion of the country. The accompanying diagram shows diagrammatically in simplified form, the unit operations.

The turbid water is treated with suitable coagulants, such as alum or iron sulfate, and properly conditioned or coagulated in a series of agitation tanks in which mixing is maintained at a velocity suited to rapid flocculation. In the mechanical sedimentation tank the floc settles rapidly, yielding a clarified effluent from which the slight remaining turbidity may be readily removed on rapid sand filters. Chlorination after filtration may or may not be employed, depending upon local conditions.

The plant of the city of Lancaster, Pa., is typical of this type of treatment. The tabulation which follows gives the salient features of the chemical treatment and the operating results of the mechanical clarifier.

Clear, Hard Water.—Clear water, excessively hard, is a common occurrence in the great hard water section of the



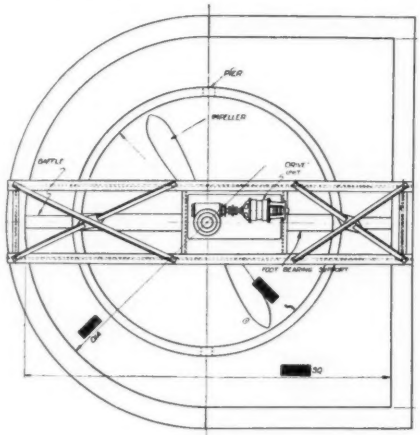
The Dorr Traction Clarifier at Kansas City, Mo.

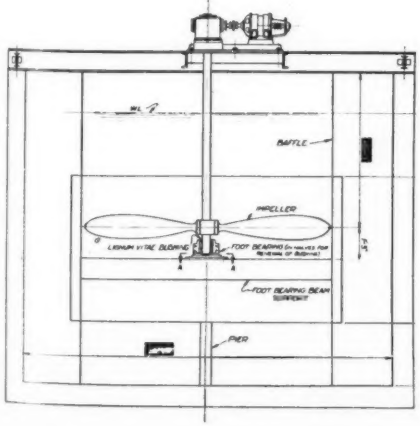
Table I—Treatment of Turbid Water at Lancaster, Pa.

Year Installed	1926
Chemical coagulants used	Alum
Flow M.G.D.	9—12
Size Dorr traction clarifier	80 ft.
Detention provided	1 hr.
Feed concentration P.P.M.	Max. 2,000
Feed concentration P.P.M.	Aver. 80
Overflow concentration P.P.M.	15—18
Clarification efficiency	80—90%

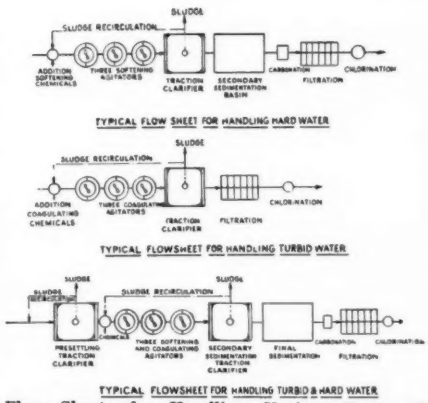
middlewest and the southwest. This condition is particularly prevalent in the states of Ohio, Illinois and Michigan, where many modern softening plants are found. The diagram illustrates a type of treatment which is used successfully for handling water of this character.

The hard water is dosed with the correct amount of softening chemicals, and the softening reaction and formation of flocs completed in the agitator tanks which follow. In the mechanical sedimentation basins the bulk of the floc is removed so that the duty on the plain sedimentation tank is greatly reduced, thus minimizing sludge accumulation and the need for frequent cleaning. The settled water is finally treated on rapid sand filters, preceded by carbonation and followed by chlorination if local conditions make these additional steps desirable.





SECTIONAL ELEVATION
Dorr Impeller Agitator


SLUDGE RECIRCULATION
SLUDGE
TYPICAL FLOW SHEET FOR HANDLING HARD WATER
TYPICAL FLOWSHEET FOR HANDLING TURBID WATER
TYPICAL FLOWSHEET FOR HANDLING TURBID & HARD WATER

Flow Sheets for Handling Various Types of Water Using Agitators and Clarifiers

In the recently designed water softening plants for the cities of Fostoria, O., Bloomington, Ill., and Boca Raton, Fla., plain sedimentation tanks have been eliminated. Single stage sedimentation in mechanical clarifiers yields an effluent containing such a small amount of suspended solids that final treatment on rapid sand filters is all that is required. Such plants as these are 100 per cent mechanically operated as far as sludge handling is concerned.

Table II gives operating data at five representative waterworks handling hard water. The treatment in general follows the lines laid down in the diagram. The raw water is clear in most cases, as it comes from deep wells. The Dorr clarifiers, which in each case remove the bulk of the floc ahead of plain settling basins, effect a 75 to 98 per cent removal of the precipitated solids, thus greatly reducing the duty on the subsequent equipment.

Turbid Hard Water.—That portion of the country which is drained by the Mississippi, Missouri, Arkansas and Red Rivers is noted for the high turbidity and moderate hardness of its water supply. These hard river waters contain turbidities ranging from 3,000 to 10,000 parts per million. Ofter for as long as a week the turbidity stays at 18,000 p.p.m. or higher, while for short periods turbidities of 40,000 p.p.m. have been observed. The difficulty of keeping non-mechanical sedimentation equipment in service under such conditions, may be visualized by considering the following. A turbidity of 10,000 p.p.m. is equivalent to 5,830 cu. ft. of 80 per cent moisture sludge per million gallons of water treated. With such an average turbidity, a sedimentation basin having a detention of 24 hours will be full of mud in 23 days, with 12 hours' detention in 11.5 days and with 6 hours' detention in 5.7 days.

The manual cleaning of settling basins in this section used to be a frequent and major operation, often requiring several weeks' work and the use of a large number of tractors, motor vehicles and teams in addition to a large force of men. Nowhere, it is safe to say, has the mechanically cleaned sedimentation basin helped so greatly in water works practice. An approved layout for handling turbid hard water provides for mechanical presedimentation ahead of chemical treatment and secondary mechanical sedimentation following chemical treatment as shown on the diagram.

The highly turbid raw water enters the mechanically cleaned presedimentation basins depositing therein about 90 per cent of suspended solids which are continuously discharged into the river. The presettled water is thereupon mixed with suitable softening chemicals, agitated at a velocity conducive to rapid flocculation and then resettled in the mechanically cleaned secondary sedimentation basin. The overflow from these, containing only a small amount of suspended material, is given a long detention in simple sedimentation tanks and filtered with or without prior carbonation and subsequent chlorination as the situation may require.

With such an arrangement the difficulties attending the handling of highly turbid waters largely disappear. Practically all of the mud and precipitate is removed and disposed of mechanically, thereby reducing the deposition in the final non-mechanical basins and filters to insignificant volume. Presettling furthermore, by reason of the low tur-

Table II—Treatment of Hard Water

Year Installed	Beverly Hills, Cal. 1928	Hinsdale, Ill. 1925	Newark, O. 1922	Granville, O. 1925	Miami, Fla. 1925
Chemical softeners used	Lime—alum	Lime—soda ash	Lime, soda ash—alum	Lime—alum, soda ash	Lime—alum
Flow M.G.D.	5	3	6	1	10
Size Dorr clarifiers	1-60 ft.	1—28 ft.	1—40 ft.	1—22 ft.	1—60 ft.
Detention provided	60 min.	60 min.	22 min.	42 min.	60 min.
Clarifier Feed:					
Alkalinity P.P.M.	7.8—8.0 P.P.M.	375	42	365	247
Soap hardness	220 P.P.M.	472	275	445	295
Clarifier Overflow:					
Alkalinity	.....	110—140	40	82	38
Soap hardness	130 P.P.M.	90—120	87	125	86
Clarifier Sludge:					
Per cent water	.....	.....	85%	90%	95%
Per cent removal susp. solids	93.5%	75%	98.5%	90—94%	.....
Treatment after mechanical clarification	1. Secondary Alum coagulation 2. Secondary sedimentation 3. Filtration	1. Secondary sedimentation 2. Carbonation 3. Filtration	1. Secondary sedimentation 2. Carbonation 3. Filtration 4. Chlorination	1. Secondary sedimentation 2. Carbonation 3. Filtration	1. Secondary sedimentation 2. Carbonation 3. Filtration

bidity effluent, results in smoother plant operation, simpler chemical control, practically halves the cost of chemicals for coagulation and softening and reduces the cost of the water wasted with the sludge, as this water has not been given the expensive chemical treatment. Furthermore, the return of a portion of raw sludge to the influent channel of the presedimentation clarifier improves the rate of settlement, presumably through entrainment of fines. A similar recirculation of chemically treated sludge in the case of the secondary clarifier has been shown to accelerate the rate of softening, probably due to a reduction in supersaturation or a catalytic speeding up of the reaction.

The use of the mechanical clarifier for presettling turbid water is a comparatively recent development. Four cities—Kansas City, St. Louis, Jefferson City, Mo., and Edmonton, Alberta—with a combined flow of 200 M.G.D. have adopted Dorr clarifiers for presettling, while St. Louis uses the clarifier for settling the chemically softened water as well. In none of these cases is operating data available at the present time.

Studies made at Jefferson City, Mo., in 1925 brought out on a semi-works scale the most important data bearing on presedimentation practice. Operating results (Table III) at Jefferson City during an 11-day run show the character of the results which should soon be obtained at the large installation referred to previously.

Presedimentation of turbid waters before chemical treatments results in a great saving in chemicals as the chemical dosage increases with the concentration of solids. Runs made at Jefferson City, treating the raw river water without presettling, showed that the coagulants required for clarification could be reduced to approximately one-half their former amount if the raw water were first presettled for three hours. Fleming, in a paper on Preliminary Sedimentation and Basin Detention at St. Louis, read in January, 1927, before the American Water Works Association, showed that his studies indicated an annual saving of $53,313 in iron sulfate and lime through subjecting 80 m.g.d. of Missouri River water to 3 hours presettling before the addition of chemicals.

The three flowsheets discussed in this paper are not to be construed as panaceas for all problems, for each problem is different from all others in a greater or lesser degree and must be approached from the professional angle as a separate and distinct one. Nevertheless the flow sheets presented do indicate the general features of plants having to contend with three frequently encountered water conditions and they do bring out the approved position of the mechanical clarifier with respect to other units in the layout.

The elimination of the difficulties inherent in the operation of intermittently cleaned settling tanks has undoubtedly been a forward step at many waterworks recently built or remodeled. The inevitable change in practice has had the cumulative effect of reducing the cost of producing a unit of potable water through continuous operation under uniform conditions which are conducive to simpler mechanical and chemical controls.

Acknowledgment.—The foregoing is an abstract of a paper presented at the 49th annual convention of the American Water Works Association.

Table III—Presedimentation Tests at Jefferson City, Mo., July 15-18, 1926

Source of water supply	Missouri River
Average suspended solids in raw water	5,844 P.P.M.
Type and size presedimentation unit	Dorr clarifier 25 ft. dia. by 8 ft. deep
Detention provided in presedimentation unit	3 hours
Average suspended solids in overflow from presedimentation unit	417 P.P.M.
Average removal of suspended solids	92.8 per cent
Type and quantity of chemicals added to presettled water:	
Iron sulfate (average dose)	3.2 grains per gal.
Lime (average dose)	3.6 grains per gal.
Secondary sedimentation unit	15 ft. by 15 ft. plain basin
Average suspended solids in overflow from secondary sedimentation unit	36 P.P.M.
Average removal of suspended solids	91.5 per cent

Per Capita Water Consumption in Metropolitan District

The following tabulation for the annual report of Frank E. Merrill, Water Commissioner of the City of Somerville, Mass., shows the per capita water consumption in the Metropolitan Water District of Massachusetts for the year 1928.

	Total Per Day	Per Capita Per Day	Services Metered*
Milton	740,000	52	100
Medford	2,902,700	56	100
Stoneham	568,200	59	100
Arlington	1,717,500	62	100
Belmont	1,079,100	62	100
Winthrop	1,070,700	62	100
Revere	2,272,000	64	93.05
Malden	3,446,700	65	99.37
Melrose	1,420,000	67	100
Chelsea	3,618,700	74	100
Lexington	637,900	76	100
Swampscott	706,700	76	100
Quincy	5,195,600	78	96.45
Somerville	8,307,800	81	100
Watertown	2,229,600	81	100
Nahant	171,200	98	99.30
Everett	5,038,800	117	100
Boston	94,570,000	117	98
Total District	135,693,200	100	98.43

*Metropolitan District Commission Report for 1927.

Hot Water Melts Ice in Pueblo Streets

Hot water was used with considerable success this last winter by the city of Pueblo, Colo., for removing snow and ice from the streets, according to E. F. Colby, superintendent of parks and highways.

The Highway Department of Pueblo is troubled considerably with light snows which result, through the compacting of traffic, in the formation of a layer of ice upon the pavements and in the gutters. This is not only unsightly, but it also creates traffic hazards and impedes drainage. As removal with picks and bars has proved expensive and, at the best, unsatisfactory, it was decided to use the hot water from the condensers of the local ice plant to remove the ice from the streets.

The regular combination sprinkling and flushing unit—a 5-ton White truck equipped with 1,100-gal. tank and auxiliary pump motor—was used. The tanks were loaded at the plant in approximately 20 minutes and arrived at the job with the water at about 175 deg. The water was released slowly under low pressure and, with the assistance of a man with a bar, rapidly thawed the ice, which was carried into the sewers.

This was found to be a highly satisfactory method for disposing of the ice if the weather is not extremely cold. At very low temperatures, the water freezes, forming a light glaze of slippery ice which is as much of a danger to traffic as the heavy coating of ice disposed of through the sewers.

Progress of City Manager Plan

The Kentucky Court of Appeals, according to the Toledo City Journal, has held the city manager act in that state unconstitutional, because it was held to (1) violate a state constitutional provision that the mayor shall be the chief executive; (2) allow an authoritative position to be appointive rather than elective; (3) be faulty in its title. Three Kentucky cities, Lexington, Covington and Owensboro, had already voted to adopt the plan at the last November election.

Redwood City, Calif., recently adopted the city manager plan. The charter contains the rather striking provision that the manager must have previous training as a city manager, assistant, or deputy manager. A similar provision is contained in the proposed plan for New Rochelle, N. Y. The charter commission in St. Paul is considering the plan and officials and civic leaders in Omaha, Nebr., are considering its adoption. The plan was recently rejected in Lincoln, Nebr.; Sedalia, Mo.; Evansville, Ind., and Terre Haute, Ind.

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Man's Descent from a "Protoplasmic Globule"

In one of Gilbert and Sullivan's operettas a character says: "I can trace my ancestors to a protoplasmic globule." Said in jest, there may be truth in the statement. At any rate it is probable that evolution is a fact, and once we start to backtrack on that trail no end seems possible, save the "protoplasmic globule," and even that is not the end.

According to authorities on geology every geological era ended, and its succeeding era began, with an ice age. Every ice age had a profound effect on animal life, certain species vanishing and new species appearing. Huntington has suggested that man completed his evolution from the simian stage during the last ice age.

If we accept this hypothesis that animal evolution was greatly hastened by ice ages and other great climatic changes, and couple it with the hypothesis that climatic changes have been caused by great variation in sunspot activity, we reach this formula: No sunspots, no man; or at least no man in his present form.

Let us go a step farther in the analysis. Sunspots are great electromagnetic whirls, and the evidence is strong that they are generated by other electromagnetic fields, namely, those produced by the axial rotation of the electrified masses of planets and comets. Lying beyond the farthest known planet, Neptune, are comets, some of which have orbital periods that run into millions of years. Since all the superior planets have comets whose aphelia lie in the orbits of the planets, it is presumable that the converse is true and that at least some of the most remote comets are similarly associated with planets as yet unseen. Since it has been demonstrated that every one of the known eight planets produces a sunspot cycle, it follows that any trans-Neptunian planet probably produces sunspots, their number and size depending upon the strength of its electromagnetic field, the direction of its magnetic axis relative to the sun and the position of its magnetic poles. When the north pole of the sun points most nearly toward the earth, more pronounced barometric laws occur, indicating that anti-clockwise rotation of solar electrons probably causes release of more terrestrial electrons and certainly causes rising air whirls. Sunspots rotate and produce similar barometric effects. So we reach the conclusion that since sunspots produce cyclonic movements of terrestrial air, certain trans-Neptunian planets caused those great storm periods that we call geological ice ages.

This brings us abruptly to another formula: No electromagnetic whirls; no man.

Since the ultimate unit of electricity that accounts for magnetic effects is the electron, we conclude: No electron, no man; and by the same token, no electron, no "protoplasmic globule."

The World's Need of Researchers

Scientific research began scarcely more than three centuries ago, with Galileo, Kepler and Gilbert. Marvelous as its achievements have been, perhaps a greater marvel is that they are the accomplishment of relatively few men. It has been the custom to explain this fact by saying that genius is a rare gift. Yet, if the phenomenon is purely one of difference in mental power, and in the rarity of that supreme power called genius, how comes it that there were almost no scientific geniuses prior to about the year 1600? Scientific genius did not suddenly evolve at that time in a few humans. We must therefore infer that men had not till then learned how systematically to interrogate Nature so as to secure definite answers to their questions.

Although this explains, in a general way, the birth of modern research, still it leaves unexplained the fewness of researchers. Even yet their number is pitifully few when contrasted either with the total population or with the economic needs of that population. Doubtless much of the reason for so little researching springs from general ignorance of the nature of research. This ignorance has served to cast a screen of mystery about the art, leading to the belief that only a few divinely gifted mortals can successfully penetrate the winding labyrinths that lead to Nature's holy of holies.

Germany has done more than any other nation to dispel this particular delusion. By training thousands of young men in research methods, German universities have proved that research ability is by no means rare. But, even in the face of such proof, America has been exceedingly slow in entering upon a career of scientific research. Most of us still regard successful research as a thing unteachable, and confined to a gifted few who will somehow or other develop their native talents even in the face of public indifference and in the absence of pecuniary support.

This last clause gives the clue to much of the apathy toward research by men capable of research. The spirit of martyrs is usually found only where public applause accompanies self sacrifice. Many a man will bravely hurl himself into any breach if he knows that his bravery will be appreciated by his fellow men. But when self-sacrifice brings not even a murmur of approval, it becomes a rare thing. The self-sacrifice of the scientific researcher is of this latter sort. He would starve in a garret if assured glory were the reward; but almost the only reward for his research work is apt to be his daily wage, for his renown will probably not extend beyond the ranks of the very few of his own scientific class who are capable of appreciating his achievement. The wonder is that these few are not fewer.

Up to very recently scientific research was almost

entirely in the hands of a few college professors. Small as the salaries of such men have been, still the income served to maintain them, and their daily duties were such as to leave some freedom for investigating natural causes and effects. If even such scant support has served to develop a body of researchers whose achievements have already revolutionized industry, imagine what might have happened in the past three centuries had the same support been provided for ten times their number.

We venture to say that not a single one of the major death-dealing diseases would remain unconquered had ten times as many biological researchers been engaged in seeking causes and cures. We are so sure that successful research is teachable, and that native research ability is not rare, that we regard it as certain that multiplying the number of trained researchers by ten would multiply the discoveries by ten. Indeed, we may safely go much farther, for each discovery itself throws light on other research problems. Hence discoveries tend to multiply in a sort of geometric progression. This is one of the reasons for the startlingly rapid advance of science within the last generation. Another reason is the pecuniary support of research laboratories by many industrial corporations. At last "big business" has begun to see that behind the inventor is the research scientist who furnishes him with his basic ideas; and that behind both inventor and scientist there must be dollars if the combined achievements of these two groups are to be rapid and great.

Take the element of time. Where Goodyear labored the better part of a lifetime to learn how to vulcanize rubber, a great modern chemical research laboratory would probably accomplish the result in a year. In the place of one Goodyear there would be a score of chemists. In the place of his kitchen chairs and tables, burned in that last fine frenzy to keep the rubber in the pot boiling while he added sulphur, there would have been exhaustless fuel.

All honor to Goodyear the Gritty, to Goodyear the Great! But where is there any honor for his blind contemporaries? Neither praise nor pay did they give him, but left him to fight his research battle alone. Does this indicate at that time a public ignorance almost barbaric? It does, and scarcely less is the ignorance of the public of today. Scourged by diseases, poverty stricken as to nine-tenths of this globe, the world is still so ignorant of what research science could do to remove these blights on health and happiness that it looks with bovine eyes at its ills and never dreams that cures are to be had. Its suffering is pitiful; its ignorance is appalling.

Tornadoes and Sunspots

The Pasadena Post recently said: "Never before have the papers of this country had to record such a series of disasters due to tornadoes as have marked the present seasons. Day after day additions have had to be made to a somber list already large beyond known precedent."

The tornado is a belt of air whirling with great velocity, and in the northern hemisphere its direction of whirl is always anticlockwise, whereas in the southern hemisphere its whirl is clockwise. As to the direction of whirl it resembles the ordinary cyclone storm that originates in the Pacific Ocean and sweeps across our continent, but the velocity of whirl is much greater in the tornado. The tornado is short lived, an hour or so, whereas the cyclonic storm often lasts a week or more. The centers of both travel eastward.

Closely allied to the tornado is the tropical hurricane. The latter is, in fact, a giant tornado whose wind velocities are not so great as those of the tornado, but whose area is vastly greater. Hurricanes move westward before they turn eastward, their paths often being almost perfect parabolas.

The following table, compiled by Wolf and quoted by Huntington in "Earth and Sun," shows how hurricanes increase in number as sunspots increase.

Number of Sunspots	Number of Hurricanes
88	8
70	5
62	4
59	3
17	1 to 2

This table gives the number of hurricanes per year, with the corresponding monthly average of sunspot numbers.

Huntington also found that during the spring months hurricanes were 69 per cent more numerous when the average number of sunspots exceeded 80 than when they were fewer than 40.

Cyclonic storms are also most numerous when sunspots are most numerous.

Since tornadoes are clearly of the same nature as cyclonic storms and hurricanes, it follows that they should be most numerous at times of sunspot maxima. Since a sunspot maximum due to the planet Juipter was due about the first of November, 1928, it was to be inferred that the spring of 1929 would be marked by many tornadoes. This inference has been verified, an unusually stormy fall and winter in northern latitudes having been followed by an exceptionally large number of tornadoes in somewhat lower latitudes.

The sunspot cycle due to Jupiter reaches a maximum every 11.2 years, unless some more electromagnetically powerful planet submerges the Jupiter effect. Uranus has caused such a submergence at times. The next sunspot maximum assignable to Uranus will occur in 1951, just six months after a Jupiter sunspot maximum; hence it is probable that an exceptionally severe period of storms will reach a climax in 1951.

From now on the Jupiter sunspot period will slowly wane. Its next maximum will occur eleven years hence, in 1940.

According to Encyclopedia Britannica, Lloyd's has found that ship casualties are 18 per cent more numerous during the two years near sunspot maxima than during the two years near sunspot minima. Although this marine insurer has based rates upon such a relationship between sunspots and storminess, still there are meteorologists and astronomers who express skepticim about sunspots as a cause of storms. Perhaps there is a difference in carefulness of investigation when you back your conclusions with your money.

H. P. Gillette

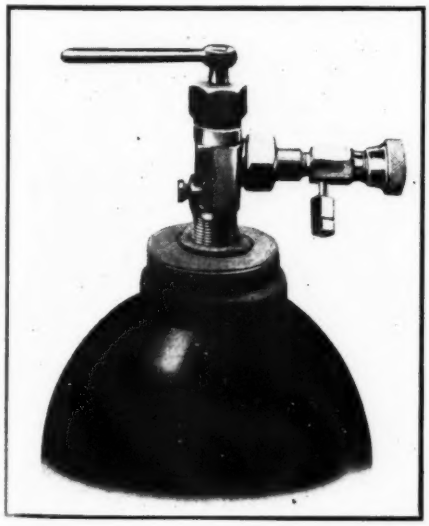
The Chlorine Institute Standard Valve for Compressed Gas, Cylinders and Drums

One of the finest examples of co-operation in the cause of public health between manufacturers of water works equipment and health and water works officials is in the development of the new Chlorine Institute Standard Tank Valve for chlorine cylinders and drums.

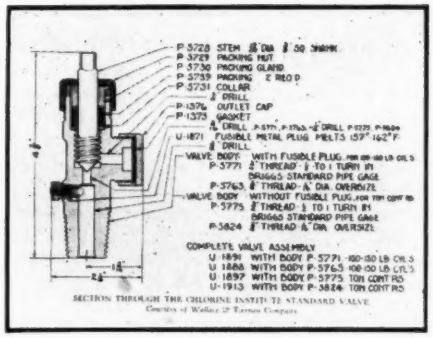
Although water works officials had for years, on frequent occasions, experienced delays and inconveniences due to receipt of a shipment of chlorine gas cylinders requiring yoke connections for auxiliary valves when fittings on hand were for the union type of attachment and vice versa. It required an emergency situation developed in the course of relief work following the Florida hurricane of 1926 to bring the seriousness of the then existing practice to a head.

The incident in point occurred at Hollywood, Fla., in September, 1926, when a shipment of several cylinders of chlorine gas delivered for emergency chlorination of water supplies could not be used because the cylinders required yoke type fittings while only the union type connections were on hand.

At a special meeting of the Public Health Engineering Section of the American Public Health Association on Oct. 13, 1926, at Buffalo, experiences in emergency chlorination of public water supplies following the Florida hurricane were the subject of a very interesting discussion. Before the close of the meeting the following motion was made by V. M. Ehlers of Texas, duly seconded and carried unanimously: "Moved that the secretary communicate with the Chlorine Institute and also the American Water Works Association with reference to the standardization of tank valves on chlorine cylinders."



Chlorine Institute Standard Valve with W & T Union Type Auxiliary Valve



Section Through Chlorine Institute Standard Valve

On receipt of communication from Arthur E. Gorman, secretary of the Public Health Engineering Section, referring to this action of the section and requesting its serious consideration by the Chlorine Institute, the directors of this organization at a meeting on Dec. 16, 1926, forwarded the communication to a special technical committee for investigation. This committee after very careful survey of conditions and a study of all types of valves, designed an entirely new valve adaptable for both union and yoke type connections which was accepted is now being manufactured. It is known as the Chlorine Institute Valve.

Investigations of this committee showed that but a relatively small percentage of the chlorine valves owned by manufacturers in the chlorine industry were used in the sanitary field. Also that the investment in these valves was a substantial one making their discards for new valves an expensive matter. However, in view of the health aspects of the situation the manufacturers decided on a policy of purchasing Chlorine Institute tank valves for the replacement of all discarded valves in use. The replacement by new valves was then confined entirely to containers used in the sanitary field.

It was estimated that this procedure would over a period of a few years permit the replacement of all valves used in the sanitary departments of their business with the new Chlorine Institute Tank Valve. It is estimated that to date there are approximately 25,000 of the new type valves in use.

They are being manufactured exclusively by the Wallace & Tiernan Co. and users report very satisfactory results with them. The new valve incorporates the best features of all valves in service. Among the features of the valve are a one piece genuine Monel metal stem, a brass forged body with 3/16 in. seat opening for the cylinder valve, and ¼ in. seat opening for the ton drum valve, an extra long and over size shank thread which allows for wear of the thread in the cylinders and gives increased length of life of the body, brass packing nut, gland and ring, so arranged as to permit packing the valve while in service, the use of soft packing, and the use of a removable bronze fusible metal container plug. The fusible metal represents the result of very extensive research work carried on by the members of the Institute. The outlet connection has the ¾ in. external straight pipe thread, which has been used in the industry for years, to accommodate a union connection and is also equipped with a recessed gasket surface to accommodate the use of an adapter and yoke. The packing nut takes the same wrench as the outlet cap.

The water works and public health professions and the members of the Chlorine Institute are to be congratulated for handling this important situation in such a business like and cooperative way. It is another indication of the fine spirit which exists in American industry in regard to public welfare.

High Curbs on Toronto Bridge Promote Pedestrian Safety

Curbs on the new steel arch bridge carrying North Glen Road over the Park Drive ravine in Toronto, Ont., were made 15 in. high to assist in preventing motor traffic from mounting to the sidewalks. Regular 6x6-in. curbs are provided at the bases of the high curbs to prevent the scraping of automobile hub caps on the walls of the high curbs.

Green Sidewalks for New Orleans

New Orleans, it is stated, is soon to have colored sidewalks. The commission council has approved the paving of the sidewalks of Baronne St., from Howard Ave. to Canal St., with light green cement. This will eliminate to some extent the glare from the strong sunlight.

Chlorine Institute Standard Valve with W & T Yoke Type Auxiliary Valve and Yoke

A New Chlorine Colorimeter

A new piece of equipment, known as the LaMotte chlorine colorimeter, for determining free or residual chlorine in drinking water, has recently been developed by the LaMotte Chemical Products Co., Baltimore, Md. The set

LaMotte Chlorine Colorimeter

consists of 8 permanent chlorine color standards in LaMotte "Sealed Nessler tubes" with polished tops and bottoms, representing 0.02, 0.04, 0.06. 0.08, 0.10, 0.15, 0.20 and 0.30 parts per million of chlorine respectively; three open Nessler tubes for the test sample; a 50 cc. bottle of Ortho Tolidine reagent with 0.5 cc. pipette and nipple; and a LaMotte Colorimeter for Nessler tube comparison. All this equipment is compactly arranged in a polished wooden case with a sturdy handle for carrying.

Previously great difficulty has been experienced with standards kept in open Nessler tubes, due to contamination from cork and rubber stoppers, and both contamination and loss of material if the solutions are kept in bottles and poured into the tubes when determinations are made. To eliminate these difficulties, all standards, including those for color, nitrogen, chlorine, iron, nitrate, etc., are put up in closed Nessler tubes with polished tops and bottoms, as recommended by F. R. Georgia (J. A. W. W. Assoc., May, 1926). The standard tubes are filled thorugh side arms which are then sealed off, preserving the standards from contamination of any kind. The special colorimeter must be used in making determinations with these sealed standards.

In making the determination, one of the open Nessler tubes is filled to the mark (50 cc.) with the water to be tested, 0.5 cc. of the Ortho Tolidine reagent added by means of the pipette, the tube shaken to ensure thorough mixing, and placed in the middle hole of the colorimeter.

Two consecutive color standards, for example, those representing 0.04 and 0.06 ppm. are then placed in the remaining two holes on either side of the test sample. The tops of the tubes are held toward a window or other source of daylight, and the standards changed if necessary, until the color of the reflection of the test sample in the mirror either matches that of the reflection of one of the standards or lies between the two. If an exact match is obtained the chlorine concentration in parts per million is read off directly from the standard with which the match is obtained. If the color lies between those of the standards on either side, the reading is taken as the average of the two. Thus if it lies between 0.04 and 0.06, it is taken as 0.05 ppm.

This set is also supplied with permanent standards and reagents for determining Nitrogen, Nitrates, Nitrites, Total Iron, Manganese, etc.

The new principle of making determinations by matching the reflection in the mirror, instead of by looking down through the tubes makes the readings much more simple and accurate.

Worthington Compressors Timken Equipped

A new line of compressors, employing Timken roller bearings on the main crank shaft journals, is announced by the Worthington Pump and Machinery Corporation, Harrison, N. J. This is the Worthington single horizontal straight line series, so popular among smaller users of compressed air. Capacities range from 100 to 300 cu. ft. per minute and, operating at moderate speeds, maintenance charges and attention are said to be almost completely eliminated.

Oil rings, which deflect the surplus oil and return it to the crank case, are mounted on the shaft beyond the Timken bearings. A special feature is the design of the crankcase enclosure. This is completely oil tight, and free from oil leaks usually found in equipment of this kind.

"Feather Valves" are standard equipment on these machines, as they are on all Worthington air and gas compressors. These valves are light strips of steel, approximately 1/32 inch thick, which flex when opening against a curved guard to permit the passage of air. They probably are the lightest and simplest air valves in use.

Regulation may be by an automatic starter and pressure switch mounted on the motor, stopping and starting it to control the air pressure between definite limits. Or a pressure regulator may be attached to the compressor inlet valves, holding them open to maintain constant air pressure. Compressors with the latter type of unloader, which bypasses the air back to suction, are claimed never to overheat when unloading.

These compressors can be furnished with ball bearing idlers for short belt drive; with Texrope drives, using V-type ropes; or a synchronous motor may be directly mounted on the compressor crank shaft, thus eliminating transmission mechanism.

Witt Concealed Garbage Can

The Witt Cornice Company have brought out their new product the Witt concealed or underground garbage can.

This modern container for the underground disposal of garbage is quickly and easily installed without expense. It is out of sight, sanitary, odorless, cannot be upset and its contents will not freeze in winter nor ferment in summer.

The complete assembly consists of (1) semi-steel durable top fitted on (2) a heavy gauge, hot-dip galvanized receptacle which contains (3) a heavy gauge corrugated, hot-dip galvanized Witt garbage can or (4) a lighter gauge corrugated, hot-dip galvanized Brighton garbage can.

After each Witt concealed can is entirely finished in the black, it is hot-dipped in pure, molten zinc. The zinc (galvanizing) knits itself into the pores of the steel and will not crack, peel or chip. It averages 4¾ oz. per square foot and furnishes the rust-resisting quality so necessary for the long life of an underground can. At the same time it seals all cracks and crevices so that each inside can is water and odor tight. Unlike paint or other covering materials, this galvanizing coating becomes a part of the metal itself. Natural underground forces rapidly corrode ordinary metals. It is therefore of primary importance that cans made for such use be of rust-resisting quality.

New Stearns Conveyor System

The Stearns Conveyor Company, of Cleveland, O., a subsidiary of Chain Belt Company, of Milwaukee, Wis., recently completed a new installation at Evanston, Ill., of a coal handling system for the pumping station.

The coal is delivered by trucks, dumped into the receiving hopper from the bottom of which a reciprocating feeder delivers it to a gravity discharge conveyor which elevates it to the upper part of the silos. In one of the silos a steel cone is suspended, this design is patented. The cone and the upper part of the silo form a live storage space from which coal is drawn through a spout from the apex of the cone into a weight carrying car traveling in front of the boilers. When the live storage space is filled the coal delivered thereafter falls through the overflow spouts to the reserve storage space.

Correction

In the June issue reference was made to the A. M. Byers Co. of Birmingham, Ala. This should have been A. M. Byers Co., of Pittsburgh, Pa. The Byers Co. has been identified with Pittsburgh industry for sixty-five years.

Application of cut back asphalt as a primer coat on existing stone base.

Application of cut back asphalt on stone which has been spread on the roadway.

Many Towns Are Resurfacing Their Streets in This Manner—

BY the use of cut back asphalt. In Clarenden Hills, a suburb of Chicago, over seven miles of streets have been resurfaced with Stanolind Cut-Back Asphalt—resulting in smooth, attractive roadways which are easy to ride on.

The retread method was used, requiring only ordinary available equipment. This method of construction is economical and is suitable for nearly all types of roadways.

Mixing and surfacing of cut back asphalt and stone on the roadway with a blade grader.

Final application of cut back asphalt before completing roadway. Note the application of ¼ inch keystone on the surface.

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DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

Just to Remind You!

The space devoted to this department is about equally divided between stories of manufacturers and distributors. Let us introduce you personally to our readers. In the technical pages of the magazines they read about your product, and how it is aiding in the progress and development in this age of scientific and mechanical accomplishment. Your organization stories and personal items appearing in Distributor News tell our readers how and where these devices are distributed for their use. We are always glad to hear from you. We like to look at pictures,—so do our readers. Send us some about yourselves. Address: Distributor News, Gillette Publishing Company, 221 East 20th St., Chicago.

United Tractor and Equipment Corp. Hold Annual Directors' Meeting

At the meeting held in Milwaukee, June 19th, Milton W. Anderson was re-elected president of the United Tractor and Equipment Corporation, according to announcement recently issued. W. B. May, president of W. B. May, Inc., Buffalo, N. Y., was elected vice-president; E. R. Wehr, vice-president of the Wehr Company, Milwaukee, secretary-treasurer, and H. T. Enns, Jr., of Chicago, assistant secretary-treasurer.

The United Tractor Corporation was organized for the purpose of developing a cooperative manufacturing and marketing plan for a full line of equipment to be used with the United Tractor to be built by the Allis-Chalmers Company. Stockholders and directors from twenty-two states and Canada met in Milwaukee, for the purpose of inspecting the various products of the United line, and the newly completed special factory in which Allis-Chalmers Company will begin increased quantity production of the Tractor on August 1st.

Mr. Anderson, who came east from the equipment distribution field in California about a year ago to organize the "nation-wide, full line movement" states that applications for membership are steadily adding to the organization, and that developments have demonstrated the soundness of the plan, which is backed by the $125,000,000 joint assets of the members. Forty manufacturers and distributors of tractors, and industrial equipment, make up the membership, which resulted from Ford's abandonment of the tractor field in this country.

When the manufacturers and distributors met in Milwaukee, demonstrations of the various United appliances were given at the proving grounds of the Trackson Company. There they viewed the Allis-Chalmers Company operate the United tractor; the crawler attachment for the United made by the Trackson Company; the road grader of the Wehr Company and other equally interesting pieces of equipment, and expressed themselves as greatly pleased with the outlook.

Directors at the stockholders' meeting were: H. C. Merritt, Allis-Chalmers; Walter H. Stiemke, Trackson Company, and E. R. Wehr, of Milwaukee; Arthur S. Hughes, the Hughes-Keenan Co., Mansfield, Ohio; Dunbar Abston, Dealers' Equipment Co., Memphis, Tennessee; A. W. Logan, Motor Power Equipment Co., St. Paul, Minnesota; C. V. Ruble, Universal Equipment Co., Kansas City, Missouri; W. B. May, W. B. May, Inc., Buffalo, N. Y., and Milton W. Anderson.

Announcement

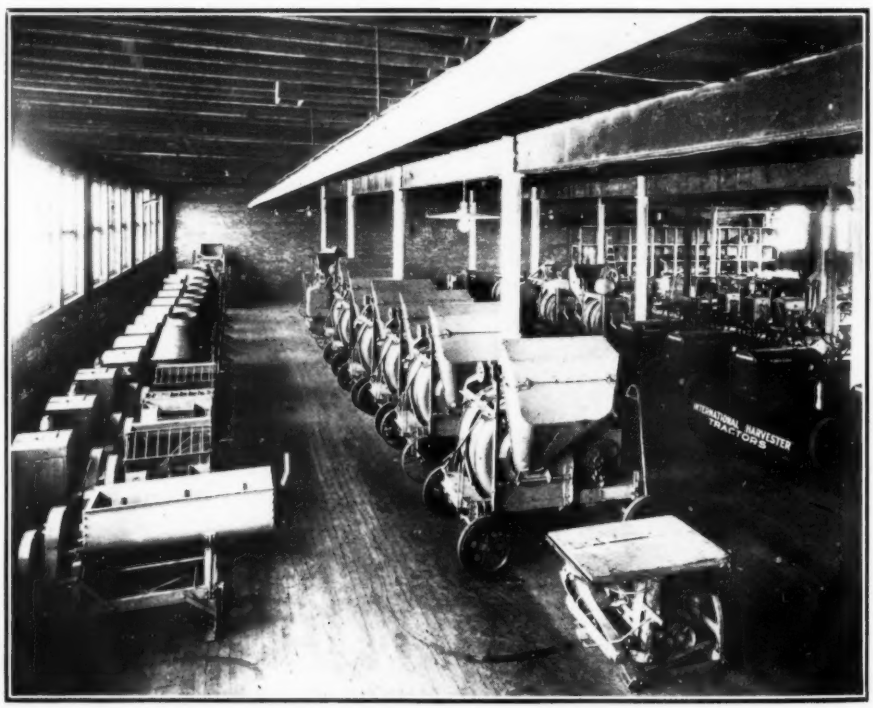
M. P. Hatcher and Albert E. Pugh announce the opening of the Water and Sewage Laboratories, 1334 Oak Street, Kansas City, Missouri, where they will conduct a general laboratory practice in the field of water purification and sewage treatment. The scope of their activities will include commercial analyses, industrial water and trade waste problems and general supervision of water or sewage plant operation.

M. P. Hatcher will continue in his present capacity, as associate engineer, with the Burns and McDonnell Engineering Company, according to announcement.

A. W. Newby Made President of Huber Manufacturing Co.

A recent announcement from the Huber Manufacturing Co. states that Mr. A. W. Newby, former vice-president of the company, has been elected president and general manager, to succeed Mr. S. E. Barlow, resigned. Mr. Barlow was elected chairman of the board.

The Huber Manufacturing Co., located at Marion, O., is known to the trade as maker of Huber four-cylinder motor roller and Huber road tractors.



Interior View H. O. Penn Company, New York
Partial view of store room of H. O. Penn Machinery Company New York City, distributors of construction machinery, showing mixers and tractors, with saw-rig in the foreground. Warehouse and offices at 140th St. and East River.

When You Come To The River

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To the aid of the highway engineer, county engineer and municipal engineer comes this new and straightforward treatise, "Economics of Highway Bridge Types." It fits the needs of the practicing engineer who, when his road must span a stream, meets a specialist's problem.

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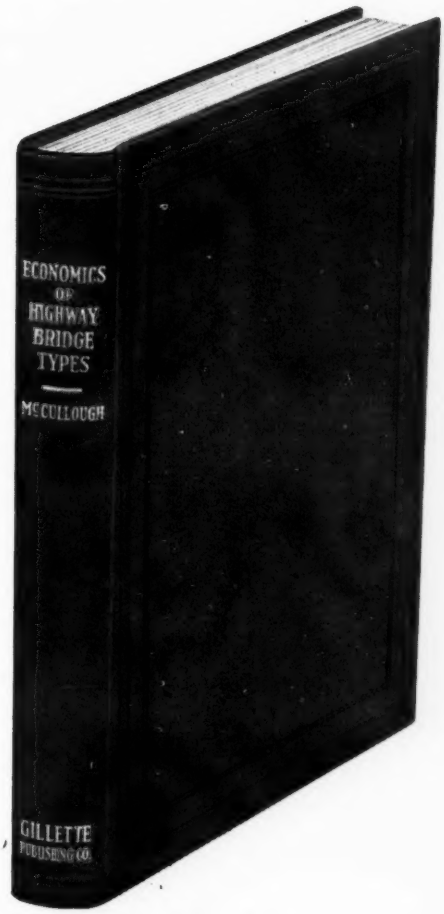

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House Magazines

Editor's Note: This column is published every now and then. Many most attractive and interesting house magazines come to our desk from time to time, and we take this method of acknowledging them.

The Spiral Stripe, No. 9, published by A. M. Byers Company, Pittsburgh, Pa., presents as its "lead-off" a picture and description of the First National Bank of Detroit. It also contains some interesting comment on new buildings in Cincinnati; Tulsa, Okla., and the Don Cesar Hotel at Passa Grille Beach, Fla. This little booklet is issued in the interest of Byers wrought iron pipe and contains some interesting information concerning this product.

U. S. Cast Iron Piper, now in its second year, presents a very attractive and interesting June number. The Piper comes from the U. S. Cast Iron Pipe & Foundry Company of Burlington, N. J. Eliminating Sewage from Nantucket Harbor; Bell and Spigot Cast Iron Pipe for Gas; Sanitary Sewer Installation at Baton Rouge, La.; and an editorial on cast iron pipe are some of the contributions in this issue.

The Mack Bulldog (No. 3. Vol. 8), which as the name implies is published by Mack Trucks, Inc., 25 Broadway, New York. Mr. A. D. Lierman is the editor. The number mentioned contains an interesting little article by Negley Farson on meeting some trucks in Soviet Russia; there is an item called "Traffic Talks"; and an interesting and convincing editorial signed A. D. L. on "Prestige As An Asset."

The lead-off story in the **Harvester World** for June, published by the International Harvester Organization, is a glowing tribute to William Ford & Company, outstanding distributor organization of Detroit, for McCormack-Deering industrial tractors and equipment. This number of the Harvester World is filled with interesting news and views of the men and women helping to carry on in the name of International.

The **Mueller Record** for July, presents a very interesting article and many illustrations showing the modernizing of the world-old system of water distribution in use at Athens, Greece. According to the story, the Greek National Government authorized a bond issue for $11,000,000, entering into a contract with Ulen and Company of New York for the design and construction of its new plant and its operation for 25 years. The contract was entered into in 1925, and details and progress of the work are told in article mentioned. Mueller Company of Decatur are publishers of the Mueller Record, which is edited by C. N. Wagenseller.

Wood Hoister for June says: "Manufacturers must be experts at discerning the ebb and flow of public tastes. No institution can afford to make a change and then sit with folded hands. Someone else is sure to have a better idea on the way." This number also presents an unusual application of a hydraulic hoist shown in a picture of Mr. Gar Wood of the Wood Hydraulic Hoist & Body Company of Detroit, seated at his telescope in his home, the comfortable seat atop the long piston of the vertical hoist.

C. R. Messinger Elected Director of Gas Light Company

C. R. Messinger, president of the Chain Belt Company, Milwaukee, was elected a director of the Milwaukee Gas Light Company, part of the American Light & Traction Company of New York. Mr. Messinger is also a director of the Sivyer Steel Castings Company, Federal Malleable Company and Interstate Drop Forge Company of Milwaukee, which are affiliated with the Chain Belt Company. He is also a director of the Nugent Steel Castings Company of Chicago. The Chain Belt Company operates a plant in Cleveland, O., under the name of the Stearns Conveyor Company.

Neil Currie Becomes Philadelphia Manager for General Electric

Neil Currie, Jr., managing engineer of the motor department of the Pittsfield Works of the General Electric Company for the past five years, has been named manager of the Philadelphia Works of the company. Robert V. Good, section superintendent in the Schenectady Works, has been named assistant to the manager at Philadelphia.

Mr. Currie, a graduate of the University of Minnesota, entered the employ of the General Electric Company in 1908 through the purchase of the power apparatus department of the Western Electric Company. Mr. Good a native of Germany, now an American citizen, entered the employ of the General Electric Company in 1913. He has been a section superintendent at Schenectady.

Announcement from Paradon

Mr. L. E. Layne has recently been appointed as a direct factory representative in charge of sales and servicing of Paradon chlorinators in the states of Illinois, Indiana and southern Wisconsin. Mr. Layne's Chicago office is at 30 North Michigan Avenue.

Headquarters of the Paradon Manufacturing Company are at Arlington, New Jersey.

Twenty-Four Hours a Day

The title of this little item sounds like a quotation from Arnold Bennett, but it is just meant to tell what the H. O. Penn Machinery Company has to offer in the way of service to its patrons. The views presented in this issue of Distributor News, tell the story "inside and out" of the men and facilities at work to serve the contractors and manufacturers depending on them for the distribution of such equipment as Rex pavers, Butler bins, Byers crane shovels, O. K. hoists and compressors, Hotchkiss steel forms, International tractors and many other well known products for use in the construction and highway industries.

H. O. Penn Company's New Home
Main office and warehouse of the H. O. Penn Machinery Company, distributors of construction and industrial equipment, embracing 25,000 square feet of warehouse space, and located at the Port Morris Terminal, 140th Street and East River, Bronx, New York.